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HISTORY AND DISTRIBUTION OF THE HUNGARIAN PARTRIDGE IN OHIO, 1909 1948[1]

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Of the many game birds introduced to the North American continent only two, the European or Hungarian partridge, *Perdix perdix*, and the ring-necked pheasant, *Phasianus colchicus*, have been successful thus far. Recent introductions of the chukar partridge, *Alectoris graeca*, also show promise of being successful.

The pros and cons of animal introductions have been discussed in a number of papers. It is definitely true that rabbits in Australia, starlings in America and the mongoose in Hawaii have become pests. But the game birds introduced in North America cannot fairly be classed as pests; they have been welcomed in a number of states and provinces; actually partridges and pheasants have completely altered the hunting picture in many areas, and it is difficult to realize the amount of hunting left if these birds were removed. King (1942), although generally opposed to the introduction of the partridge and the pheasant in America, mentions that probably 90 percent of the upland bird shooting in Oregon is produced by the partridge and pheasant; and the importance of the pheasant as a game bird in the cornbelt needs no elaboration.

Graham (1944) raises four questions to be answered by the ecologist who is trying to evaluate the feasibility and legitimacy of exotics.

The first question is: Will they survive? Our present knowledge of the ecology of any animal is not and may never be so complete that we can accurately predict the results of introductions into new environments.

The second question is whether the new species will spread widely, take the place of a now useful species, or otherwise seriously upset present conditions. The biological implications resulting from such introductions is of great concern to naturalists and wildlife managers.

Ohio was originally 95 percent forested. Today a relatively small percentage of the state is in forest. This drastic change in landscape naturally affects the game of the state. The wild turkey and prairie chicken disappeared; the ruffed grouse became scarce and is presently restricted to southeastern and eastern Ohio; the bobwhite quail expanded its range; and none of the prairie grouse immigrated from the west into the newly created open lands of Ohio.

[1]The material here presented was collected while the author, during the years 1947–1949 studied as a wildlife research fellow of the Ohio Cooperative Wildlife Research Unit: The Ohio State University, the Ohio Division of Wildlife, the U. S. Fish and Wildlife Service and the Wildlife Management Institute cooperating.

Sincere appreciation is expressed to Drs. Daniel L. Leedy and Charles A. Dambach for guidance and advice; to Drs. George A. Petrides and Eugene H. Dustman for the stimulation of discussions; also my sincere thanks to the agencies making the full study possible.

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The bobwhite quail is close to its northern limit in Ohio; it has never consistently occurred in large numbers in this state, and it has been protected from hunting since 1912.

As no native game bird was left, and as no upland game birds voluntarily moved into the newly created habitat in western and northwestern Ohio (except for the bobwhite quail which does not thrive too well there), the importation and release of pheasants and partridges must be considered a morally legal, economically sound and practical procedure.

The third question posed by Graham is whether the new species is more valuable than a native species now available. This question has already been answered above; there was no native game bird present in numbers in the habitat in which introduction of partridges was tried.

The fourth question to be answered is whether the introduced species can maintain itself successfully, or will require special care. In Ohio, the partridge thrived well for a number of years, but was very low in numbers by 1949. It does not look as if it is the low of a cycle; it looks as if the bird was gradually disappearing from many areas. Only the future can give the answer here.

LIBERATIONS

The first introductions of partridges into Ohio took place about 1909. Between 1909 and 1916 a total of approximately 2000 birds were released in almost every county of the state; World War I put a stop to the importations, but again from 1924 until 1930 new shipments of partridges were received, totalling about 7000 birds. These birds were liberated in all but 14 unglaciated hill counties (Hicks, 1935).

The distribution of the partridge in Ohio as of 1930 is shown in figure 1.

From 1932–1940 partridges were again purchased and planted in northwestern and central western Ohio, this time totalling 8420 birds.

According to the information in the files of the Ohio Division of Wildlife the following numbers of partridges were liberated during the period 1932–1940:

1932	100 birds released
1933	132 birds released
1934	none
1935	746 birds released
1936	none
1937	1383 birds released
1938	1403 birds released
1939	2686 birds released
1940	1970 birds released
1932–1940	8420 partridges released

As to the expenses involved in the importation of Hungarian partridges, the correspondence dealing with the matter has been checked in the files of the Ohio Division of Wildlife. Unfortunately not all bills and letters are left, but a reasonable estimate of the amounts involved and not accounted for can be had by comparison with figures for the first introductions of partridges in Pennsylvania (Gerstell, 1940).

From 1909–1916 and from 1924–1930 a total of about 9000 partridges were imported from Europe. The price per pair seems to have been about $7.50, making a total of $33,750.00. The payment for the 2686 birds received in 1939 was $8,997.00, and the payment for the other partridges received seems to have been about $6.75 per pair, for the remaining 5734 birds totalling $19,352.25.

The total sum paid for the 17,420 partridges released by the Ohio Division of Wildlife is estimated at $62,100.

According to the correspondence concerning the shipments in the late thirties it appears that the birds imported came from Czechoslovakia.

INCREASE AND DECREASE

Few data are available about the early results of partridge liberations in Ohio. On the basis of fragmentary information an attempt will be made to reconstruct the pattern of increase, attained maximum and decrease.

Apparently the early plantings attained a good foothold in certain areas. Only a few years after the 1915-plantings in northwestern Ohio, partridges shifted in 1916 or 1917 over the border to southern Michigan where they colonized Lenawee County (Yeatter, 1934).

In all of the eastern and southern parts of the state the liberations seem to have been failures. Trautman (1940) mentions liberations of partridges in the area around Buckeye Lake in 1915, but this experiment was a failure. Another experimental release of 15 pairs of partridges on a postglacial lake bed in the same region seemed successful for a couple of years but failed eventually. Hicks (1933)

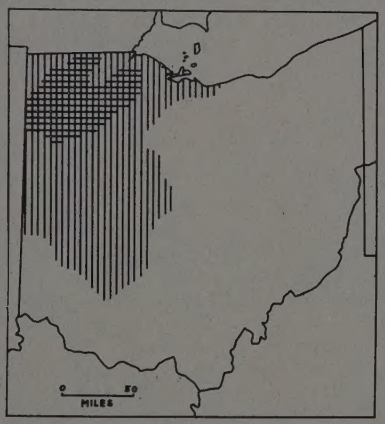

Figure 1

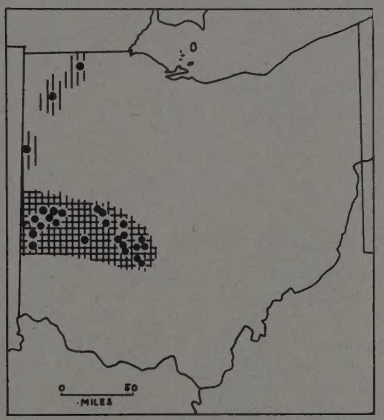

Figure 2

FIGURE 1. Distribution of the Hungarian partridge in Ohio in 1930, modified after distribution map by Hicks. Highest concentration (in the former Lake Maumee area) is indicated by cross hatching.

FIGURE 2. Distribution of the Hungarian partridge in Ohio by 1948. Dots indicate recorded coveys.

mentions the failure of an introduction of 24 birds in Cherry Valley Township, Ashtabula County, in 1930; two broods were raised in 1930, one nest was found in 1931, but no trace was found of the birds in 1932.

Partridges established themselves during the twenties, mainly on the lacustrine limestone soils of former Lake Maumee, and in fairly good numbers on the glacial limestone soils of western Ohio, except in the southern part of this area.

The peak of population density seems to have been reached somewhere around 1930 or in the early thirties. Reports of decrease began in the latter half of the thirties.

The highest partridge populations were found in northwestern Ohio, namely in the lake bed counties: Henry, Wood, Defiance, Paulding, Fulton, Van Wert, Allen, Hancock, Putnam, and Lucas. In this area the partridge, to about 1935, averaged 25 or more birds per square mile (Hicks, 1935).

The partridge was considered common to abundant when populations reached that density. According to Old World standards, in the partridge's native habitat, this is a very low population. Data from 84 Danish farms and estates (Westerskov, 1949a) in 1945 gave an average of 21 pairs per square mile in spring; the resultant

fall population would number 200 in a year of good production. For the very best partridge habitat, 400 partridges per square mile has been recorded. On the well-managed partridge beats in England the partridge population is higher than in Denmark. Maxwell's figures (1911) indicate a maximum kill of one bird per 2.3 acres during the best years, or 278 birds per square mile, corresponding to about 600 birds per square mile in the fall, based upon an average harvest of 55 percent as shown for English estates by Middleton (1935).

Some data are available on the partridge population in Ohio in the late thirties.

The partridge harvest by farmers and residents in 1937 in 15 northwestern counties was estimated at 10,098 birds (Hicks, 1939c).

During 1938 fall roadside counts showed an average of 27 partridges per 1000 miles of auto travel (Hicks, 1939a) and the estimated partridge harvest by farm residents for 1938 was 24,836 birds in 31 counties (Hicks, 1939d).

In the fall survey conducted in 1939, 42 partridges were seen during 62 man-days, or 15 partridges per 1000 miles of auto travel (Hicks, 1939b). The estimated partridge harvest in 12 counties that year was 6,434 birds (Hicks, 1941).

In 1940 the number of partridges had decreased to 6 per 1000 miles of auto travel, (Hicks and Leedy, 1940) and in 1941 to 1.3 per 1000 miles of auto travel (Hicks *et al.*, 1941).

The war put a sudden stop to these surveys.

In 1946 not a single partridge was observed during the summer in 56 man-days in four counties, whereas in previous years the numbers of partridges observed were as follows: 1938, 18; 1939, 11; 1940, 15. (Leedy, 1946).

In the summer of 1947 two partridges were seen in 19 man-days, covering 1358 miles (Leedy, 1947a). Not a single partridge was seen in September 1947 during a survey (conducted morning and evening) covering 1864 miles (Leedy, 1947b) or during the 1948 summer and fall surveys (Leedy, 1948a, 1948b).

All records obtained during my field work and from questionnaires and reports during 1947 and 1948 are shown in Fig. 2. A total of 26 partridge coveys were located. It will be seen that the bird had disappeared from most of its former range in northwestern Ohio and around 1947–48 most of the birds remaining in the state were found in the counties extending westward from Columbus towards the Indiana line, mainly in Madison, Fayette, Champaign, Clark, Miami and Darke. Scattered birds were found, however, here and there in the formerly inhabited range, indicating that small "pockets" of birds still existed. These birds under favourable breeding conditions may serve as a reservoir in bringing the partridge back as an important game bird in Ohio, but it is rather doubtful.

From the available data, the peak of the partridge population seems to have been somewhere in the early thirties. The population density was highest in the Lake Maumee area. The only year for which estimated population densities are given for the major part of the partridge range is 1939. In the lake bed counties the number of partridges varied between 1.1 and 34.8, with an average of 14 birds per square mile. For the remaining number of counties studied, the number of birds estimated per square mile varied between 0.01 and 16.9, the average being 5.6 birds per square mile.

The total number of partridges for the counties discussed (Hicks, 1939d) is estimated to have been slightly in excess of 110,000 birds.

A total of 24,836 partridges was estimated to have been bagged by the farmer-hunters in the northwestern and western counties in 1938 (Hicks, 1939d), including all but the three southernmost partridge counties, where the partridge population, however, was very low. For the whole partridge range in Ohio, the number of partridges killed by farmer-hunters, in 1938, may be estimated at 24,900 birds. If we assume that about half of the hunters in the field are city-hunters, and that their kill amounts to about the same as the kill by the farmers, the total estimated kill would amount to about 50,000 partridges. Long established shooting records

from England (Middleton, 1935) indicate an average kill of 55 percent of the population. Figuring on a 50 percent kill, a total of 100,000 partridges should have been found at the beginning of the hunting season, which corresponds closely with the comparative figures for population density.

An interesting parallel with the Ohio decline can be had by a comparison of the kill estimates from Indiana and the gradual decline figures for Ohio. The Indiana data supplement the Ohio figures, and as the partridge inhabited area is of about the same size in the two adjoining states (the partridge populations actually

TABLE 1

Comparative data for the kill of partridges in Indiana (Barnes, in litt.) and Ohio. Figures indicate estimated number of birds killed.

YEAR	INDIANA	OHIO
1940	47,457	42,250
1941	34,900	37,000
1942	33,019	31,750
1943	26,436	26,500
1944	17,384	21,250
1945	15,256	16,000
1946	15,677	10,750
1947	10,163	—

TABLE 2

Open seasons on the partridge in Ohio (Dambach, 1948). Only years with changes from the foregoing are listed.

YEAR OF LAW	BAG LIMIT	OPEN SEASON	LENGTH OF OPEN SEASON
1917	—	Nov. 15–Dec. 4	20 days
1919	6	Nov. 15–Nov. 25	11 days
1931	4	Nov. 15–Nov. 25	11 days
1938	4	Nov. 15–Nov. 30	16 days
1939	4	Nov. 8–Nov. 30	23 days
1940	4	Nov. 15–Nov. 30	16 days
1942	4	Nov. 20–Dec. 5	16 days
1943	4	Nov. 19–Dec. 4	16 days
1944	4	Nov. 17–Dec. 2	16 days
1946	2	Nov. 15–Nov. 30	16 days
1947	—	Protected	
1948	—	Protected	

merge into one another), the striking similarity might be said to be more than coincidental and substantiates the Ohio figures.

The estimated kills of partridges in Indiana (Wm. B. Barnes, *in litt.*, 11.24.1948) and Ohio are shown in table 1.

The seasons and bag limits for partridges in Ohio are shown in table 2. It will be seen that partridge hunting was begun in 1917, only eight years after the first introductions, indicating a rapid increase in numbers during these first years.

SUMMARY

1. Introduction of the Hungarian partridge into Ohio was justified as no native game bird was found in any numbers in the new habitat created when forest lands were converted to croplands.

2. Between 1909 and 1940 a total of 17,420 partridges were imported from Europe (Czechoslovakia) and were released in all parts of the state. The total cost of the birds was $62,100.

3. Partridges increased in numbers in western and northwestern Ohio up till about 1937–40 when a rapid decline began. At its peak in the thirties the fall population numbered about 100,000 birds.

4. The decline in the Ohio partridge population seems to be general and not a cyclic low.

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Ohio Fossils. *Aurele La Rocque* and *Mildred Fisher Marple.* Bulletin 54, Ohio Division of Geological Survey, Columbus. 1955. v +152 pp. $1.00 (including tax).

This informative volume on Ohio fossils will be welcomed by professional geologists and amateur collectors alike. Primarily designed for those who have never studied the subject before, the book's clear non-technical language and abundant illustrations and definitions meet this objective very well. At the same time its comprehensive coverage of Ohio fossils and discussion of collecting areas should be most helpful to the advanced collectors, especially those not now familar with Ohio.

The first three chapters serve as an introduction and background to the remaining seven which describe the fossils themselves, arranged by geological formation, and illustrated by 413 line drawings. Simple keys are provided for most of the groups described. The References Cited and Index sections are each eight pages in length.

This paper-bound volume may be obtained from: Division of Geological Survey, Orton Hall, Ohio State University, Columbus 10, Ohio.

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FIBROSARCOMA ASSOCIATED WITH THE CYSTICERCUS OF *TAENIA TAENIAEFORMIS* IN THE LIVER OF A MUSKRAT

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The larval stage (cysticercus)[1] of *Taenia taeniaeformis* (Batsch, 1786) is a common parasite in the liver of rats and mice. The association of these larvae with sarcomatous growths in the liver of rats has long been known, and has been extensively used in the study of carcinogenesis for over thirty years. In numerous investigations, Bullock and Curtis (1920, 1924, 1925, 1926 and 1928) have employed *T. taeniaeformis* larvae to induce malignant growth of the connective tissue in the liver of rats. Although the parasite has been found in a number of rodents (table 1), a coexisting fibrosarcoma of the liver has not been reported in any animal other than the albino laboratory rat. The occurrence of this association in a feral muskrat is therefore noteworthy.

In the fall of 1953 a muskrat, *Ondatra zibethica zibethica* (L.), was found dead in a small corn field adjacent to the Olentangy River in Columbus, Ohio. The animal appeared to have died recently and was removed to the laboratory where it was examined for parasites.

The liver was greatly enlarged and half of the organ was replaced by yellow-brown, friable tumor tissue (fig. 1). The carcass was disposed of before examination for metastases to other organs was made. Three cysticerci of *T. taeniaeformis* were removed from the central portion of the tumor mass. After fixation in 75 percent alcohol under glass slide pressure, these worms measured 26.8, 19.3 and 18.7 cm. in length; the maximum width was 3 mm. (fig. 2).

Histological sections of the liver show massive replacement of hepatic cells by neoplastic connective tissue (fig. 3). The tumor is composed of elongated spindle shaped fibroblasts arranged in poorly defined interlacing bundles. The nuclei are large and pleomorphic; bizarre mitotic figures are frequently encountered (fig. 4). The neoplasm has the histological characteristics of a fibrosarcoma.

DISCUSSION

Taenia taeniaeformis is commonly parasitic in the small intestine of the domestic cat and other felines. Gravid proglottids are passed with the fecal material and the intermediate host ingests the eggs with feces-polluted food or water. The onchospheres pass through the stomach and are liberated in the small intestine where they penetrate the intestinal wall. Carried via the portal circulation to the liver, they become lodged in the capillaries of this organ. After about 6 days larvae can be found in small vesicles on the surface of the liver. The walls of the vesicles are formed by the proliferation of host connective tissue. Approximately 7 mo. are required for the larvae to become fully grown infective strobilicerci with caudal vesicles. When the definitive host (feline) eats the infected rodent liver, the larvae, freed by digestion, attach to the intestinal wall. The worms mature in 35 to 42 days when eggs first appear in the feces. The life cycle is completed in a minimum of 250 days.

The incidence of cysticerci of *T. taeniaeformis* in wild rat populations varies, according to the locality, from 8 to 96 percent. The surprisingly low incidence in roof rats (table 1) reported by Huggins (1951) is probably correlated with their

[1]Also called *Cysticercus fasciolaris*.

restriction to the upper stories and roofs of dwellings, smoke houses, outhouses and other buildings, and less common occurrence in open fields. Such behavior allows for little exposure to gravid proglottids in cat feces.

The incidence in muskrats is comparatively low, usually not exceeding 6 percent. Warwick (1936) indicates that in the British Isles the rate of infection is also low. However, Rider and Macy (1947) and Byrd (1952) found a higher level of infection. Other "unusual" hosts for this larval cestode are listed in table 1. In none of these reports is mention made of a coexistent sarcoma in the liver.

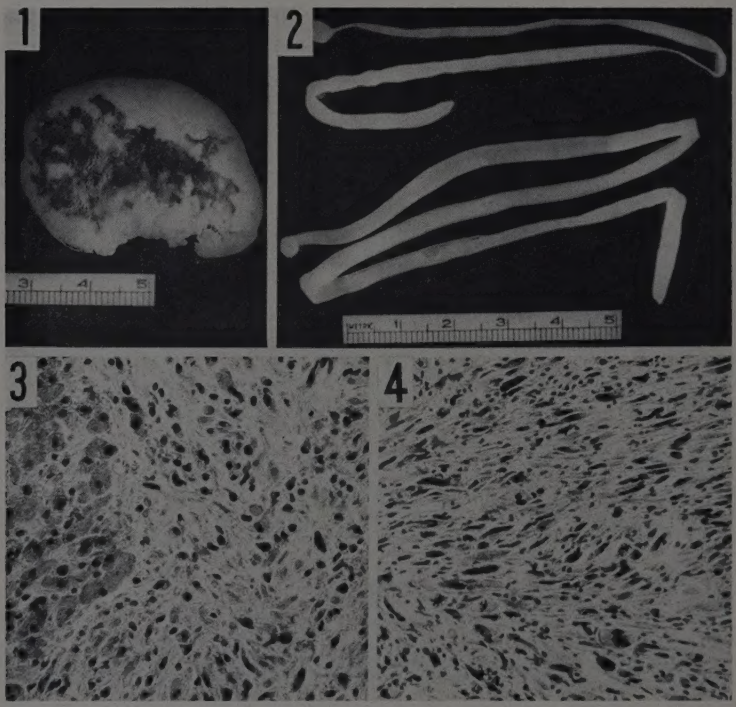

FIGURE 1. Cut surface of tumor showing extensive haemorrhage.
FIGURE 2. Two of the cysticerci (*Taenia taeniaeformis*) recovered from the neoplasm.
FIGURE 3. Section of liver showing distortion of normal architecture by fibrosarcoma (right). Polyhedral liver cells (left) showing pyknotic nuclei and granular cytoplasm probably the result of post-mortem autolysis. Hematoxylin and eosin stain. Mag. X 255.
FIGURE 4. Area of the tumor showing spindle shaped malignant fibroblasts with pleomorphic bizarre nuclei, several of which show abnormal mitotic figures. Hematoxylin and eosin stain. Mag. X 155.

Recent attempts have been made by Dunning and Curtis (1946 and 1953) to identify the active carcinogenic substance in the cysticerci. Their results (1953) indicate that "a highly labile agent capable of inducing sarcoma when introduced into the peritoneal cavity of rats may be present in larvae of *Taenia taeniaeformis* that have resided 12 or more months in the liver of other rats of the same strain."

TABLE 1

Incidence of Taenia taeniaeformis larvae in the liver of rodents

Host	No. exam.	No. with larvae	% pos.	Locality	Author
Norway rat, *Rattus norvegicus* Erxleben	50	5	10%	Portage Co., Ohio	Forbes, 1942
" " " " "	400	40	10%	Panama City	Calero, Ortiz & deSouza, 1950
" " " " "	55	7	12.7%	North Carolina	Harkema, 1936
" " " " "	200	35	17.5%	Bronx Zoo, New York	Herman, 1939
" " " " "	2500	480	19.2%	Baltimore, Md.	Luttermoser, 1936
" " " " "	100	54	54%	Washington, D. C.	Price & Chitwood, 1931
" " " " "	65	63	96%	Columbus, Ohio	Voke, 1955
"house rats" (presumably *R. norvegicus*)	26	21	80.7%	Ohio	Rausch & Tiner, 1949
roof rat, *Rattus rattus frugivorus* Raffinesque	102	1	0.98%	Brazos Co., Texas	Huggins, 1951
osage wood rat, *Neotoma floridana osagensis*	50	4	8%	Payne Co., Oklahoma	Murphy, 1952
cottonrat, *Sigmodon hispidus hispidus* Say & Ord	200	31	15.5%	North Carolina	Harkema & Kartman, 1948
cottonrat, *Sigmodon hispidus hispidus* Say & Ord	100	28	28%	Georgia	Harkema & Kartman, 1948
cottonrat, *Sigmodon hispidus hispidus* Say & Ord	30	10	33%	Brazos Co., Texas	Huggins, 1951
"wild rats" (genus and species not mentioned)	532	428	80.5%	Bloomington, Ill. (garbage dump)	Wantland, 1953
muskrat, *Ondatra zibethica zibethica* (L.)	36	0	0	South East Texas	Chandler, 1941
" " " " "	108	1	0.92%	Hamilton, Ontario	Sweatman, 1952
" " " " "	104	1	0.96%	Maine	Meyer & Reilly, 1950
" " " " "	250	6	2.2%	North and central Illinois	Gilford, 1954
" " " " "	230	3	1.3%	Ft. Snelling, Minnesota	Penner, 1940
" " " " "	34	1	2.9%	Tonka Bay, Minnesota	" "
" " " " "	17	1	5.8%*	Upper Grass Lake, Minn.	" "
" " " " "	13	1	7.7%*	Gideons Bay, Minnesota	" "
" " " " "	2	1	50%*	Edina, Minnesota	" "
" " " " "	252	8	3%	South and Central Mich.	Ameel, 1942
" " " " "	53	3	5.6%	Central New York	Edwards, 1949
" " " " "	70	4	6%	Ohio	Rausch, 1946
" " " " "	205	14	6.8%	British Columbia	Knight, 1951
" " " " "	6	3	50%*	Western Massachusetts	Rankin, 1946
muskrat, *Ondatra zibethica rivalica* Bangs	53	0	0	Louisiana	Penn, 1942
muskrat, *Ondatra zibethica osoyoensis* (Lord)	34	0	0	Western Colorado	Ball, 1952
muskrat, *Ondatra zibethica occipitalis* (Elliot)	34	10	29%	North western Oregon	Rider & Macy, 1947
muskrat, *Ondatra zibethica* (no subspecies named)	54	19	35.2%	Montgomery Co., Va.	Byrd, 1952
muskrat, *Ondatra zibethica* (no subspecies named)	420	12	2.8%	British Isles	Warwick, 1936
house mouse, *Mus musculus musculus* L.	84	3	3.57%	North Carolina	Harkema, 1936
prairie meadow mouse, *Microtus ochrogaster*	46	1	2.8%	Ohio, Mich., Ind., Ill., & Wisc.	Rausch & Tiner, 1949
meadow mouse, *Microtus pennsylvanicus pennsylvanicus*	570	43	7.5%	Ohio, Mich., Ind., Ill., & Wisc.	Rausch & Tiner, 1949
meadow mouse, *Microtus pennsylvanicus pennsylvanicus*	3	1	33%*	Minnesota	Erickson, 1938
fox squirrel, *Sciurus niger rufiventer* Geoffrey	1	1	*	Manhattan, Kansas	Dobrovolny & Harbaugh, 1934
fox squirrel, *Sciurus niger rufiventer* Geoffrey	1	1	*	Lincoln, Nebraska	Martin, 1930
" " " " " "	94	2	2.1%	Ohio, Mich., Ind., Ill. & Wisc.	Rausch & Tiner, 1948
southern gray squirrel, *Sciurus carolinensis carolinensis* Gmelin	53	1	1.89%	North Carolina	Harkema, 1936
rabbit, *Lepus americanus* (from back muscles)	1	1	*	Nova Scotia	Mahon, 1954

*The few animals investigated leave doubt about the actual level of infection in the total wild population.

The absence of cancer in association with these parasites when the latter occur in animals other than the albino white rat would suggest that a host factor is also important for the induction of this neoplasm.

SUMMARY

A fibrosarcoma in the liver of a muskrat was found associated with the cysticercus of *Taenia taeniaeformis* (Batsch, 1786). Three cysticerci were embedded in the neoplastic connective tissue that largely replaced the normal liver structure.

ACKNOWLEDGMENT

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Botany: Principles and Problems. *Edmund W. Sinnott* and *Katherine S. Wilson.* McGraw-Hill Book Company, Inc., New York, 1955. vii+519 pp. $6.75.

The authors have succeeded admirably in their attempts to modernize this fifth edition of a well established and widely adopted text of botany. One who has successfully used the previous editions of this book will find to his delight that there is a much more thorough survey of the information about plants which has accrued to science in recent years. The entire format of the book has undergone radical alteration much the better for the student reader. The pages are larger and the text is arranged in two columns. This has resulted in a considerable number of desirable and important changes in the order and content of chapters. Questions for thought and discussion follow each chapter but there are no summaries.

The chapter on the History of Botany has been expanded because of its importance and is shown as a good example of how most sciences develop. The chapter treating on the cell and protoplasm has been revised and has in addition new figures which better illustrate its new title which is the Physical Basis of Life.

The chapter on Metabolism has been completely rewritten and different emphasis is given the subjects of photosynthesis and respiration treating them simply but in professional style without oversimplification or obscuring them in technical detail.

The section, chapter four, of the older editions of the text which dealt with Soils has been transferred to the chapter on Environment in the new edition and the treatment of soils as factors of the environment has been greatly expanded considering modern discoveries of conditioners, fertilizers, mycorrhizal relationships of roots and fungi, and of new soil biotic factors.

There is no glossary of botanical terms, but the book includes a well developed Appendix of Greek and Latin roots from which plant science terms are derived and a very accurate index.

The quality and organization of the illustrations in this book have improved so much that it is difficult to recognize the text as the one which has had so many previous editions. The pleasant color of the binding of this book, its modern cover, larger size, and complete renovation all combine to extend this book above and beyond its previous meritorious position. It should prove to be of inestimable value as a text for general botany courses and if the reviewer is any judge will be very well received.

ARTHUR H. BLICKLE.

A SYNOPSIS OF THE GENUS BARINUS CASEY IN NORTH AMERICA

(Coleoptera Curculionidae)

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While studying the members of the genera *Barinus* Casey and *Barilepton* LeConte recently, the author discovered several new forms and not a little confusion as to the limits of these genera. The species falling in the genus *Barinus* are discussed here. Those falling in *Barilepton* and related genera with connate claws will be discussed in a forthcoming paper.

The two afore mentioned genera are very alike in general appearance and in most morphological characters, thus leading to considerable confusion. The only reliable character for separating the two genera, which can be easily distinguished, is the form of the tarsal claws. In *Barilepton* the last tarsal segment is single and not in the least cleft at the tip. In *Barinus* the last tarsal segment has two claws though these are very closely connate to near the tip in some species. In *Barinus robustus* (Blatchley) and *Barinus productum* (Casey) this character is a little difficult to see but careful examination will show that the claws are actually connate to very near tip. There are no basic differences in either the male or female genitalia.

The author is indebted to the persons and institutions which made material available for study. The author is particularly indebted to Miss Rose E. Warner of the United States National Museum, Dr. Milton W. Sanderson of the Illinois State Natural History Survey and Dr. J. J. Davis who made arrangements which allowed the author to examine material in the Blatchley Collection at Purdue University.

Barinus Casey

Barinus Casey 1886, p. 255. Blanchard 1887, p. 87. Blatchley and Leng 1916, p. 411.

Elongate-oval to very elongate and linear; rostrum rather short, never longer than the prothorax, thick, curved; head rather large, strongly rounded; antennae inserted beyond the middle of the rostrum in both sexes; scrobes oblique, passing beneath at the base of the rostrum; prosternum usually deeply and narrowly impressed or sulcate; scutellum small, usually denuded; tarsal claws connate at least to middle.

Genotype: *Barinus squamolineatus* Casey would be the genotype by monotypy, but it is a synonym of *Barilepton cribricolle* LeConte, thus *cribricolle* becomes the genotype.

Most of the species of *Barinus* occur east of the Rocky Mountains. *Barinus difficilis* Casey apparently occurs in Southern California as the holotype and only example known to the author was from Southern California according to Casey. Most of the species are rather southern in distribution. *Barinus cribricollis* (LeConte), however, ranges northward to New York and Michigan.

All species occur in swampy or very wet areas. Most species breed in various sedges and grasses. One species has been recorded from *Sagittaria*.

Key To the species of *Barinus* in North America

1. Elytra each with one complete stripe of white or cream scales from base to apex; the remainder of the elytra glabrous 2
1'. Elytra squamose above, the scales forming shorter or longer lines on most of the elytral intervals 3
2. The complete stripe on each elytron confined to intervals 4, 5 and 6 *bivittatus* (LeConte)
2'. The complete stripe on each elytron confined to the second interval; the base of intervals 1, 3, 4, 5, and 6 may be clothed with a few scattered scales. *elusus* Blatchley

3. The scales lineate in arrangement on other than the second and third elytral intervals; when the latter are densely squamose throughout, intervals 2, 4, and 6 are paler at least basally 4
3'. Elytra rather evenly squamose above, the scales not lineate except for a feeble line on part of the second and third elytral intervals 6
4. Body not densely squamose throughout; many intervals sparsely clothed at least in part with narrow setalike scales ..... *cribricollis* (LeConte)
4'. Body densely squamose throughout, all elytral intervals with broadly clavate scales of near uniform size, the scales yellowish brown in color, but white on the even intervals, usually paler, especially towards base 5
5. Prothorax with the scales of the ventral side large and dense toward the sides; pronotal punctures finer and moderately close ..... *suffusus* Casey
5'. Prothorax with a large apparently denuded area on the flanks of the ventral side toward the base, on which the scales become very sparse, pronotal punctures coarse and denser ..... *difficilis* Casey
6. Form more broadly oval; (fig. 3) 7
6'. Form elongate, very narrow; (fig. 7) 9
7. Vestiture dense, the scales broad, large; the anterior coxae separated by about one-fourth their diameter ..... *lutescens* (LeConte)
7'. Vestiture sparse, the scales narrow-elongate; the anterior coxae separated by nearly one-half their diameter 8
8. Larger, over 3.0 mm.; apex of prothorax very feebly, almost imperceptibly constricted ..... *curticollis* Casey
8'. Smaller, 2.4 mm.; apex of prothorax prominently constricted ..... *debilis* Casey
9. Vestiture on the prothorax abruptly dense on the flanks, the pronotal area glabrous ..10
9'. Vestiture on the prothorax not abruptly limited, more evenly distributed, although some examples have the pronotum more sparsely clothed but not glabrous 11
10. First and third elytral intervals with one or two rows of scales, the remaining intervals with one row; over all vestiture sparser ..... *productum* (Casey)
10'. All elytral intervals with two or more rows of scales, more densely clothed species ..... *albescens* (LeConte)
11. Pronotum convex; elytra more densely clothed, with lateral partially denuded areas ..... *convexicollis* n. sp.
11'. Pronotum flat; elytra sparsely evenly clothed, without denuded areas 12
12. Intercoxal prolongation of prosternum strongly constricted, fused to posterior part of prosternum, no transverse suture apparent between the coxae (fig. 6); larger species, 6.7–8.0 mm ..... *robustus* (Blatchley)
12'. Intercoxal prolongation of prosternum truncated between the anterior coxae, a transverse suture very evident. (fig. 4) 13
13. Very sparsely clothed with very small, broadly clavate scales which do not overlap on the disc of the elytra; elongate narrow species (the maximum width divided by total length, excluding rostrum, from .2747–.2831) ..... *linearis* (LeConte)
13'. Very densely clothed with more elongate clavate scales which overlap on the disc of the elytra; broader than the preceding species (the width divided by the length, excluding rostrum, from .2940–.3099) ..... *confusus* n. sp.

Barinus bivittatus (LeConte)

Figure 1

Barilepton bivittatum LeConte 1878, p. 431.

Barinus bivittatus (LeConte), Blanchard 1887, p. 87. Casey 1892, p. 668. Blatchley and Leng 1916, p. 412.

Elongate, convex; polished black with a faint metallic luster, the legs reddish black; vestiture confined for the most part to two lines of closely placed yellowish white scales extending from the apical margin of the prothorax to the apex of the elytra.

Rostrum three-fourths as long as the prothorax, stout, cylindrical, feebly compressed laterally, evenly arcuate, coarsely punctured basally. Antennae inserted just beyond middle, first segment of funicle very slender and as long as the remaining segments. Club small, elongate-oval and as long as the four preceeding segments combined.

Prothorax slightly broader than long, feebly inflated in apical third, the sides then straight to base, apex feebly constricted; the basal lobe almost obsolete; pronotum coarsely but not very densely punctured with a narrow, irregular, impunctate, entire median line. Scutellum small, slightly wider than long.

Elytra as wide and twice as long as prothorax, the sides feebly arcuate, converging to the apex; striae fine and deep, not punctured; intervals wide, sparsely and confusedly punctured.

Ventral side clothed with white scales, the meso- and metaepisterna and lateral margins of the abdominal segments densely clothed with white scales. Prosternum narrowly, moderately deeply sulcate along middle. Anterior coxae separated by only one-third their width. Tarsi very broad; the posterior pair as long as the tibiae, scaly above, densely pilose beneath. Claws connate for fully half their length.

Length 5.0–5.8 mm., width 1.6–2.0 mm.

Type locality.—"Florida and Georgia". Type in the LeConte Collection at the Museum of Comparative Zoology.

Distribution. Known from various localities in Northern Florida, Georgia, South Carolina and Alabama. Collected on *Sagittaria*.

Easily separable from all other species by the striking appearance which is wholly unlike that of any other North American Barid.

Barinus elusus Blatchley

Barinus elusus Blatchley 1920, p. 264; 1922, p. 120; 1928, p. 256.

Elongate, subparallel, convex; shining black, with the antennae and legs reddish brown; prothorax with a broad stripe of white scales on each side, elytra with the second intervals completely covered with similar scales, bases of intervals 1, 3, 4, 5 and 6 similarly clothed.

Rostrum three-fourths the length of the prothorax, stout, strongly curved, very sparsely and finely punctured above, punctures coarser laterally in the basal half. Head finely alutaceous, sparsely and finely punctured. First funicular segment two-thirds the length of the remainder united.

Prothorax one-fourth longer than wide, the sides subparallel to beyond apical fourth, then narrowed to apex; pronotum finely punctured, the surface feebly alutaceous.

Elytra scarcely wider at base and two times longer than the prothorax, sides parallel to apical fourth, then strongly rounded to apex; striae narrow, deep; intervals flat, feebly alutaceous, each with a single row of rather fine, shallow, irregularly placed punctures.

Ventral side with the meso- and metaepisterna and lateral margins of the abdominal segments densely clothed with white scales; surface coarsely and densely punctured, the last three abdominal segments more sparsely so.

Length 3.0–3.3 mm., width 1.2–1.3 mm.

Type locality.—Skinner's Hammock, Dunedin, Florida. Type in the Blatchley Collection at Purdue University. Type examined.

Distribution. Known only from the type locality.

This species is close to *cribricollis* (LeConte), but separable by the more slender form and the arrangement of the scales on the elytra.

Barinus cribricollis (LeConte)

Barilepton cribricolle LeConte 1876, p. 422.

Barinus cribricolle (LeConte), Blanchard 1878, p. 87.

Barinus cribricollis (LeConte), Casey 1892, p. 669. Blatchely and Leng 1916, p. 412.

Barinus squamolineatus Casey 1886, p. 256; 1892, p. 670. Pierce 1916, p. 9. Blatchley and Leng 1916, p. 413. (New Synonymy).

Elongate, oval, convex; black, with the antennae and legs reddish black; vestiture uneven, consisting of closely placed white scales in a lateral stripe on the prothorax, on the second elytral interval to near apex where the scales become yellowish brown, on the third interval for a short distance behind middle, on the fourth near base and from basal fourth to apical fourth, on sixth broader, denser, more conspicuous and confined to the basal fourth.

Rostrum short, not more than two-thirds as long as the prothorax, robust, arcuate, strongly punctured on the base laterally. First funicular segment as long as the remaining segments. Head alutaceous, sparsely and finely punctured.

Prothorax nearly as long as wide, the sides parallel and straight in basal two-thirds; then gradually rounded to the rather strongly constricted apex; pronotum coarse, deep and moderately separated; an impunctate median line present in basal two-thirds.

Elytra distinctly wider than, and more than twice as long as prothorax, the sides feebly

arcuate from humeri to apex; striae narrow and deep, strial punctures nearly obsolete; intervals flat, unequal in width, much wider than the striae, finely and confusedly punctured.

Ventral side strongly punctured, thinly clothed with white scales which are denser on the meso- and metaepisterna and the lateral margins of the abdominal segments. Prosternum deeply, longitudinally impressed. Anterior coxae separated by less than one-third their own width. Claws closely connate.

Length 3.1–3.8 mm., width 1.2–1.4 mm.

Type localities.—Of *cribricollis* (LeConte), Enterprise, Florida, type in the LeConte Collection; that of *squamolineatus* Casey, "Illinois", type in the Casey Collection in the United States National Museum.

Distribution. New York west to Michigan and Iowa, south to Texas and Florida. Swept from saw-grass in Florida, sedges and various swamp grasses in Ohio. Also taken by sifting in low swampy areas in February and March.

After study of a long series of both *cribricollis* and *squamolineatus* the author can come to no other conclusion than that they are synonyms. Material compared with the type of *cribricollis* when compared with *squamolineatus* were found to be slightly different, but these differences are due to regional variation only. Many intermediate forms can be found in the area between the type localities as well as in the vicinity of the type localities. There are no differences in the genitalia.

Barinus suffusus Casey.

Barinus suffusus Casey 1892, p. 670.

Elongate-oval, convex; black with the antennae and legs red; vestiture very dense throughout made up of large brownish scales which become white toward the base of the sixth interval and feebly whiter on the second and fourth near the base and behind middle; the prothorax densely clothed laterally, sparsely clothed on pronotum.

Rostrum about four-fifths as long as the prothorax, thick, compressed, strongly arcuate, coarsely punctured basally, finer apically. Antennae inserted a little beyond middle. First funicular segment not quite as long as the remaining segments. Club as long as the preceding five segments united, elongate, densely pubescent. Head finely, strongly, moderately sparsely punctured.

Prothorax slightly wider than long, the sides straight and parallel in the basal two-thirds, then broadly rounded and feebly convergent to the broadly constricted apex, the median lobe of the base very small and feeble; pronotum finely and rather closely punctured, a feeble impunctate median line present. Scutellum denuded and shining.

Elytra wider than and a little more than twice as long as prothorax, the sides feebly convergent from humeri to apex; striae narrow (except the first), deep, the punctures obsolete, the first broad, deep and with rather coarse, deep, distant punctures; intervals flat, wide, coarsely punctured, the latter usually obscured by the dense vestiture.

Ventral side densely clothed with white scales which are sparser along middle of the abdominal segments; coarsely and closely punctured. Abdominal segments of ♂ convex with an impression on the first; of the ♀, convex, the fifth with a small impressed denuded area. Claws closely connate.

Length 3.5–4.0 mm., width 1.3–1.4 mm.

Type locality.—"Texas". Type in the Casey Collection. Type examined.

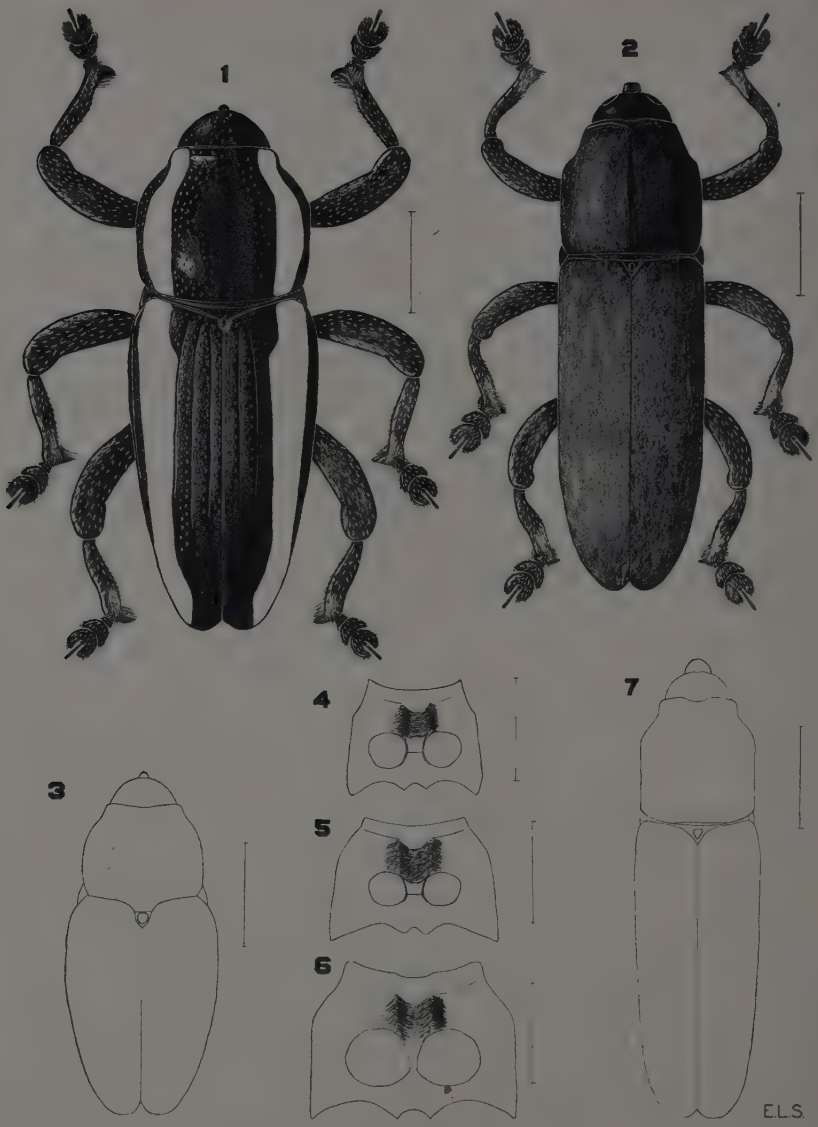
Distribution. All examples seen by the author were from various places in Texas. Examples from El Paso were taken from stems of various grasses.

This species can be separated from all others by the much denser vestiture and the arrangement of it, as mentioned in the key.

Barinus difficilis Casey

Barinus difficilis Casey 1892, p. 671.

Elongate-oval, convex; black, with the antennae and legs reddish; densely clothed with large closely placed pale brown scales becoming white in the basal half of the second and sixth and at base of the fourth elytral intervals and on the flanks of the prothorax.



1. *Barinus bivittatus* (LeConte), ♂.
2. *Barinus confusus* n. sp., ♂, holotype.
3. Outline of *Barinus curticollis* Casey.
4. Ventral view of prosternum of *Barinus linearis* (LeConte).
5. Ventral view of prosternum of *Barinus confusus* n. sp.
6. Ventral view of prosternum of *Barinus robustus* (Blatchley).
7. Outline of *Barinus linearis* (LeConte).

(Line represents 1 mm.)

Rostrum much shorter than the prothorax, glabrous, arcuate and densely punctured basally. First funicular segment distinctly shorter than the remainder united. Head finely, sparsely punctured and glabrous.

Prothorax slightly wider than long, the sides parallel and nearly straight to apical third, then broadly rounded and convergent to apex, no apical constriction apparent; pronotum coarsely, deeply and closely punctured; a median, impunctate, fusiform line present. Scutellum quadrate and denuded.

Elytra slightly wider than long a little more than twice as long as the prothorax, the sides parallel to near apical fourth, then convergent to apex; striae fine; intervals wide, flat, moderately coarsely and densely, deeply confusedly punctured.

Ventral side with the sides of the pronotum (except for a large apparently denuded spot just before the mesoepisterna), meso- and metaepisterna and the abdominal segments densely clothed with large paler scales. Prosternum normal, very narrowly separating the anterior coxae. First abdominal segment with a moderate depression. Claws closely connate.

Length 3.25 mm., width 1.25 mm.

Type locality.—"Southern California". Type in the Casey Collection. Type examined.

Distribution. Known only from the unique holotype, a male.

This species is closely allied to *suffusus*, but differs in the much more sparsely punctured head, the coarser, denser punctures, the narrower lateral stripe and the denuded area on the flanks of the pronotum.

Barinus lutescens (LeConte)

Barilepton lutescens LeConte 1880, p. 218.

Barinus lutescens (LeConte), Blanchard 1887, p. 87. Casey 1892, p. 672. Blatchley 1922, p. 120.

Elongate-oval, robust, moderately convex; black, with the antennae and legs reddish black; densely clothed with large yellowish brown scales, which are elongate, evenly distributed on the elytra, where they become gradually semi-erect behind and denuded at the sides in basal half, dense on the flanks of the prothorax.

Rostrum three-fourths as long as prothroax, thick, strongly arcuate, strongly punctured basally. First funicular segment as long as the next five. Club small, slightly longer than the preceding four segments combined.

Prothorax one-third wider than long, the sides parallel and nearly straight in the basal two-thirds, then rounded, convergent and scarcely at all constricted at apex; pronotum coarsely and sparsely punctured, the punctures smaller and much denser anteriorly. Scutellum very small, quadrate, denuded and shining.

Elytra slightly wider than and slightly more than twice as long as the prothorax, the sides parallel to apical two-fifths, then rounded to apex; striae fine; intervals broad, flat, rather finely, moderately and densely punctured.

Ventral side shining and with very remote, setiform scales, which become abruptly denser and broader on the meta-episterna and on the lateral margins of the abdomen. Prosternum rather deeply and very narrowly sulcate. The anterior coxae separated by hardly more than one-fourth their width. Claws closely connate.

Length 3.2 mm., width 1.3 mm.

Type locality.—Columbus, Texas. Type in the LeConte Collection.

Distribution. Known only from two examples, the holotype a ♀, and an example of undetermined sex, Dunedin, Fla.,III-26-22, W. S. Blatchley, in the Blatchley Collection.

This species is allied to *albescens*, although differing greatly in form, the arrangement of the vestiture on the ventral side is almost identical, *lutescens* does not possess the denuded subapical spot on the elytra and is more coarsely punctured.

Barinus curticollis Casey

Figure 3

Barinus curticollis Casey 1892, p. 673. Blatchley and Leng 1916, p. 413. Blatchley 1925, p. 103.

Barinus ferruginosus Casey 1920, p. 513. (New Synonomy).

Narrowly oblong-oval, convex; shining, black, with the legs dark reddish black; densely clothed with yellowish elongate-oval scales on the pronotum laterally, on the elytra the scales are sparser, becoming finer laterally.

Rostrum about two-thirds as long as the prothorax, thick, very strongly arcuate, coarsely and sparsely punctured basally. Antennae slender, first funicular segment not quite as long as the remaining united.

Prothorax two-fifths wider than long, the sides parallel and straight to the apical third, then gradually rounded, convergent and nearly straight to the apex; pronotum coarsely deeply and sparsely punctured; with a narrow and irregular impunctate median line. Scutellum small, oval and glabrous.

Elytra slightly wider than and almost two and one-half times as long as prothorax, the sides feebly rounded to an obtusely rounded apex; striae deep; intervals flat, two to three times wider than the striae, coarsely, confusedly and rather sparsely punctured.

Ventral side very sparsely clothed with scales except on metaepisterna and the lateral margins of the last three abdominal segments where the scales are much denser. Abdominal segments finely, remotely punctured, the first segment a little more coarsely and closely punctured. Anterior coxae separated by about one-half their width.

Length 2.7–3.8 mm., width 1.0–1.5 mm.

Type locality.—Of *curticollis*, Saint Louis, Missouri, of *ferruginosus* the same. Types of both in the Casey Collection. Types examined.

Distribution. Rather local at various localities in Maryland, District of Columbia, Illinois, Missouri, Florida, Mississippi, Louisiana, and Texas.

This species is nearest *debilis* Casey, but differs notably from that by the feebler apical constriction of the prothorax and the larger overall size. The type of *curticollis* is a ♂, while that of *ferruginosus* is ♀. The latter species is only a robust ♀ of the former.

Barinus debilis Casey

Barinus debilis Casey 1920, p. 513.

Oblong, parallel, moderately convex; shining, black, with the antennae and legs reddish black; dorsum rather sparsely clothed with elongate whitish scales which are more distinct on the sides of the prothorax.

Rostrum about three-fourths as long as the prothroax, thick, strongly, evenly arcuate, strongly punctured basally. Antennae inserted slightly beyond the middle. Club and funicle about as long as the rostrum.

Prothorax about one-fourth wider than long, the sides nearly straight, subparallel to apical third, then rapidly rounding and oblique to the feebly constricted apex; pronotum coarse, separated by nearly their diameter, smaller apically; a smooth, abbreviated, median line present.

Elytra about as wide and more than twice as long as the prothorax, the sides parallel, rounding at the apex; striae narrow and deep, strial punctures obsolete; intervals wide, flat and with fine and confused punctures.

Ventral side with very minute and slender, sparse scales which become dense on the metaepisterna and the lateral margins of the last three abdominal segments.

Length 2.4 mm., width 0.85 mm.

Type locality.—"Louisiana". Type in the Casey Collection. Type examined.

Distribution. Known only from the type example.

This species is nearest to *curticollis* but differs notably from that by the stronger apical constriction of the prothorax and the smaller overall size.

Barinus productum (Casey) n. comb.

Barilepton productum Casey 1920, p. 514.

Elongate, parallel, strongly convex and cylindrical; feebly shining, black, with the legs reddish; rather sparsely clothed with fine whitish scales which become a little denser on the sides of the prothorax; the scales a little coarser on the elytra where they form single or partial double lines on the intervals being a little denser at the base of the second and apically on the

third interval.

Rostrum about two-thirds as long as the prothorax, thick, cylindrical, very strongly arcuate, finely and sparsely punctured basally. Antennae inserted slightly beyond middle.

Prothorax nearly as long as wide, the sides feebly arcuate to apical three-fifths, then rounding and oblique to the apex; pronotum with punctures rather small and unevenly separated, an abbreviated, impunctate, median line distinct. Scutellum denuded.

Elytra only as wide as and more than twice as long as the prothorax, sides straight, parallel to behind middle, then rounded to apex; striae fine and deep, strial punctures obsolete; intervals wide, flat and with an uneven series of small and feeble punctures.

Ventral side sparsely clothed with white scales, becoming denser on the metaepisterna and the lateral margins of the last three abdominal segments. First abdominal segment narrowly impressed at middle, the fifth segment broadly and feebly impressed at middle apically in the male. Claws very closely connate, but definitely cleft.

Length 3.3 mm., width 1.0 mm.

Type locality.—"Southern Louisiana". Type in the Casey Collection. Type examined.

Distribution. Known only from the unique holotype, a male.

This species is nearest *albescens*, but with the vestiture much more sparse, not as strongly condensed laterally on the prothorax. On the elytra intervals 1 and 3 with one or two rows of scales, the remainder with one row, while *albescens* has two or more rows on all intervals.

Barinus albescens (LeConte)

Barilepton albescens LeConte 1880, p. 218.

Barinus albescens (LeConte), Blanchard 1887, p. 87. Casey 1892, p. 674. Blatchley and Leng 1916, p. 413. Pierce 1916, p. 10.

Elongate, subparallel, feebly convex; shining, black, with the antennae and legs; very densely, though a little unevenly, clothed with large, elongate, yellowish white scales which are very dense on the sides of the prothorax and throughout the elytra, except along the lateral margins and in a discal spot near apex, these apparently denuded areas and the median area of the prothorax are clothed with very sparse setiform scales.

Rostrum three-fourths as long as the prothorax, very thick and arcuate, strongly punctured basally. Antennae with the first funicular segment as long as the next five united. Club large, pale and nearly as long as the preceding six segments.

Prothorax slightly longer than wide, the sides nearly straight, slightly divergent from base to apical third, then strongly convergent and deeply constricted to apex; pronotum finely and sparsely punctured; the smooth median line distinct. Scutellum very small and denuded.

Elytra at base scarcely wider than the prothorax, the sides straight and very feebly divergent to apical third, then broadly rounded to apex; striae fine and deep; intervals almost impunctate in the denuded lateral areas, coarser elsewhere.

Ventral side clothed with very minute and sparse scales which are denser on the metaepisterna and on the lateral margins of the last three abdominal segments. Prosternum longitudinally and narrowly sulcate. The anterior coxae narrowly separated. Claws closely connate.

Length 2.5–3.4 mm., width 0.8–1.2 mm.

Type locality.—Columbus, Texas. Type in the LeConte Collection.

Distribution. Known from a large series from Columbus and Victoria, Texas and a single example from Westville, New Jersey. Pierce records this species from *Cyperus pseudovegetus* Steud. (*Cyperus virens* Michx.).

This species is not closely related to any other species but is apparently nearest to *productum* (Casey) differing in the characters discussed under that species. Also apparently allied to *lutescens* (LeConte) in that the arrangement of the vestiture on the ventral side is almost identical, but *lutescens* is much broader in form.

Barinus convexicollis n. sp.

Male.—Elongate, narrow, moderately convex; black with the femora and tibiae dark reddish black; densely clothed with broadly clavate, appressed white scales which are slightly denser on the second interval.

Rostrum three-fourths as long as the prothorax, strongly, evenly arcuate, not suddenly bent, finely sparsely punctured along median line, laterally coarsely, deeply punctured in basal two-thirds; apex smooth, shining, very sparsely punctured. Antennae inserted one-third from apex; scape not attaining eyes; first funicular segment elongate, slightly longer than the following three united, second segment slightly longer than the third. Club oval, finely and densely pubescent. Head strongly alutaceous, sparsely, shallowly punctured; the front with a deep, oval puncture between the eyes. Eyes elliptical and coarsely granulated.

Prothorax as broad as long, the sides feebly divergent from base to near middle then strongly constricted to apex; pronotum coarsely, closely, deeply punctured, a narrow, median smooth line entire; pronotum a little less densely clothed with scales than the flanks. Scutellum rounded.

Elytra scarcely wider and twice as long as the prothorax, almost twice as long as wide, the sides parallel from humeri to just beyond middle, then rounded to the apex; striae very narrow and deep, strial punctures very fine, widely separated; intervals flat, strongly alutaceous, finely punctured; disc feebly undulate.

Ventral side strongly alutaceous, sparsely clothed with white scales except on the episterna and lateral margins of the last three abdominal segments. Abdominal segments strongly convex, the first not impressed at middle, the fifth segment with a denuded area but no other modification. Last tarsal segment short, extending only about half its length beyond the third segment. Claws closely connate.

Length 3.8 mm., width 1.3 mm.

Female.—Differs from male only in that the fifth abdominal segment has a deep transverse apical groove. Length 3.6 mm., width 1.3 mm.

Type locality.—Highlands Hammock, Highlands Co., Florida.

Type material. Holotype, ♂, allotype, 2 ♂ and 4 ♀ paratypes, Highlands Hammock, Fla., V–5 53, N.J. & E.L. Sleeper all in the author's collection; 1 ♀, Alachua Co., Fla., VII 14–54, H.V. Weems, Jr., in Florida State Plant Board Collection. Length of paratypes 3.1 4.0 mm., width 1.1 1.4 mm. The examples from Highlands Hammock were swept from saw-grass on a small island in the cypress swamp.

This species is nearest *B. albescens* (LeConte), but is more convex, more sparsely clothed, without the glabrous area on the pronotum, lacks the denuded areas on the elytra and has darker legs.

Barinus robustus (Blatchley)

Figure 6

Barilepton robusta Blatchley 1920, p. 170.
Barinus robustus (Blatchley), Fall 1928, p. 240.

Elongate, subcylindrical, robust; feebly shining, black, with the antennae and legs reddish brown; uniformly and densely clothed with gray scales.

Rostrum about one-half as long as the prothorax, stout, compressed, basal half coarsely punctured, the punctures becoming finer and the surface smoother apically. Head alutaceous, very finely and sparsely punctured.

Prothorax one-half longer than wide, the sides parallel from base to apical third, then strongly constricted to the apex; pronotum flattened, closely and coarsely punctured; an almost entire, narrow, smooth median line present.

Elytra as wide as and three times longer than the prothorax, the sides parallel to apical fifth, then feebly converging to apex; striae fine and shallow, strial punctures not apparent; intervals flat, wide, alutaceous, moderately coarsely, irregularly punctured.

Ventral side densely clothed with scales which are smaller than those on dorsum, oval and gray. Abdominal segments strongly convex, the first segment in ♂ with a longitudinal impression, the fifth segment unmodified, the ♀ with the first abdominal segment strongly convex, the fifth segment with a feeble median longitudinal impression that terminates in a deep pit near the apical margin. Claws feebly cleft, very closely connate.

Length 6.7–8.0 mm., width 1.9–2.5 mm.

Type locality. "Margin of a lake 3 miles east of Lakeland, Florida" (Lake Parker, Polk

County, Fla.). Holotype, ♀, in the Blatchley Collection at Purdue University. Type examined.

Distribution. Rather general in Central Florida where saw-grass occurs.

This species with *linearis* (LeConte) and *confusus* n. sp. form a complex set off a little from the other members of the genus. They all may be readily separated from one another by the characters mentioned in the key.

Barinus linearis (LeConte)

Figure 4

Barilepton lineare LeConte 1876, p. 422.
Barinus lineare (LeConte), Blanchard 1887, p. 87.
Barinus linearis (LeConte), Casey 1892, p. 674. Blatchley and Leng 1916, p. 414.

Very elongate, parallel, convex; feebly shining, black, with the legs reddish; sparsely and uniformly clothed with very small, broadly clavate scales which do not overlap on the disc of the elytra, on the sides of the elytra a little sparser.

Rostrum about two-thirds as long as the prothorax, robust, strongly arcuate, strongly coarsely punctured in the basal half, more finely and sparsely punctured apically. First funicular segment scarcely as long as the next four together. Head strongly alutaceous, very finely and sparsely punctured.

Prothorax slightly longer than broad, the sides straight and parallel to apical two-fifths, then rounded and convergent to a feeble apical constriction; pronotum flattened, strongly alutaceous, moderately closely and coarsely punctured, an impunctate, fusiforme median line entire.

Elytra just visibly wider than and more than twice as long as the prothorax, the sides parallel and slightly narrowed to the apical third, then rounded to the apex; striae fine and deep, the strial punctures almost obsolete; intervals wide, flat, rather finely, unequally, confusedly and very closely punctured.

Ventral side sparsely clothed with gray scales, except on the metaepisternum and lateral margins of the last three abdominal segments. Prosternum impressed longitudinally. Anterior coxae rather narrowly separated. Intercoxal prolongation of the prosternum truncated between the anterior coxae, a transverse suture very evident. Claws closely connate.

Length 3.7–5.0 mm., width 1.0–1.4 mm.

Type locality.—Sumter County, Florida. Holotype, ♀, in the LeConte Collection.

Distribution. Sumter and Putman Counties, and Haw Creek, Florida. Taken from clumps of saw-grass near Crescent City, Fla.

This species is nearest *confusus* n. sp., but may be separated from that species and *robustus* (Blatchley) by the characters set forth in the key. Also see the discussion after the treatment of *robustus*.

Barinus confusus n. sp.

Figures 2 and 5

Male.—Very elongate, narrow; black, with the antennae, legs and tarsi reddish brown; densely clothed with elongate, clavate, white appressed scales which are rather uniformly distributed over the dorsum.

Rostrum five-eighths as long as prothorax, strongly curved, coarsely, deeply, closely punctured in basal two-thirds, smoother and more finely punctured apically. Antennae inserted two-fifths from apex; scape not attaining eyes; first funicular segment very elongate, almost as long as the following four combined, second segment half again as long as third. Club oval, densely and finely pubescent. Head strongly alutaceous, very sparsely and shallowly punctured on the front between the eyes. Eyes prominent, the edges raised above the surface of the head and very coarsely granulated.

Prothorax quadrate, as broad as long, the sides subparallel in the basal five-eighths, then narrowed to the apex; pronotum flat, very deeply, coarsely and closely punctured, faint evidence of a smooth median line which does not reach base or apex; vestiture uniformly distributed. Scutellum small and rounded.

Elytra slightly wider than and almost two and one-half times longer than the prothorax,

more than twice as long as broad, the sides parallel in basal three-fifths, then rounded to apex; striae narrow, deep, strial punctures obsolete; intervals very feebly convex, strongly alutaceous, confusedly punctured.

Ventral side moderately clothed with elongate clavate white appressed scales and rather densely punctured. Prosternal prolongation truncated between the coxae. Abdominal segments strongly convex, neither the first nor the fifth modified. Claws closely connate.

Length 5.1 mm., width 1.5 mm.

Female.—Differs from the male only in that the fifth abdominal segment has a feeble depression near the middle of the apical margin. Length 6.2 mm., width 1.75 mm.

Type locality.—About 7 miles east of Florida City along Florida City Canal and Palm Drive, Dade County, Florida.

Type material.—Holotype, ♂, Dade Co., Fla., III–I, allotype, same locality, IV–10, 3 ♂ paratypes, same locality, II–24, all in the author's collection. Length of paratypes 5.2–6.0 mm., width 1.6–1.8 mm. All examples were taken from the bases of clumps of saw-grass.

This species is nearest *B. linearis* (LeConte), but may be easily separated by the denser vestiture, more quadrate prothorax, and the more robust form.

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The Geology along Route 40 in Ohio. *Pauline Smyth.* Information Circular No. 16, Ohio Division of Geological Survey, Columbus. 1955. vi+65 pp. $.25.

This interesting booklet is one of a series by the Geological Survey, designed to acquaint the average person with the geology of Ohio.

The author divides the National Road into 25 sections, from the Ohio River to the Indiana boundary. Each is represented by a map of a scale of ½ inch to the mile, on which is shown the geological, and many of the cultural, features of the area, together with a page of explanatory text. There are other helpful charts and maps and numerous excellent photographs.

The booklet will appeal not only to the beginner but also to the advanced amateur and even the professional geologist whose specialty happens to lie in other areas. Every traveler over U. S. 40 would do well to have a copy.

EDWARD S. THOMAS.

ADAPTATION OF THE RAT TO A HIGH LACTOSE DIET. EFFECT OF THE SIZE OF THE CECUM[1]

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As a dietary constituent, lactose has some characteristics which set it apart from other common food sugars. The ingestion of fairly large quantities of lactose by man and all the laboratory species which have been tested is often followed by laxation or diarrhea, probably due to a hydragogue action of unhydrolyzed, hence unabsorbable, lactose in the intestinal tract. The feeding of equal parts of glucose and galactose is not ordinarily followed by laxation. References to the pertinent literature are found in the review by Fischer and Sutton (1949), and for the most part will not be repeated here.

In the laboratory rat fed a very high level (45–87.5%) of lactose in the diet, diarrhea, sometimes followed by death, has been reported by numerous investigators. Riggs and Beaty (1947) found that young rats exhibited transient diarrhea when fed 20, 25 or 30 percent lactose in a purified diet. Increasing the lactose level to 40 or 50 percent was followed by more severe and persistent diarrhea as well as by retarded growth. However, the rat often becomes adapted to diets containing fairly high percentages of lactose, the diarrhea subsiding after several days or weeks. In the present paper, the remission of lactose-induced diarrhea in rats maintained on a lactose diet, or failure of a test animal to develop diarrhea on a lactose diet which elicits this symptom in control rats is referred to as adaptation of the rat to lactose. Other changes in the animal, such as enlargement of the cecum, are not included in the term adaptation as used here.

In a study (Lawrence, 1953) to explore the possible mechanism of adaptation of the albino rat to a high lactose diet, evidence was obtained that an observed increase in the lactose-hydrolyzing power of the bacterial mass in the cecum might contribute to adaptation. However, the rise in the specific lactose-splitting power of the cecal flora (as judged by the specific lactase activity in the feces) was found to reach its maximum in 4 to 5 days whereas the rat did not become fully adapted to the lactose diet until several days or weeks afterwards. These facts indicate that the increased lactase specific activity of the cecal contents cannot alone be responsible for adaptation. In another study (Fischer and Sutton, 1953) it was shown that there is a moderate increase in the rate of intestinal "absorption" of lactose in rats fed 25 percent of lactose in the diet for six weeks. This increased lactose "absorption" probably is one factor in the adaptation process. Other possible factors need to be considered also. For example, several investigators have mentioned incidentally that abdominal distention and enlargement of the cecum occurs in rats fed high lactose diets. Sometimes the cecal enlargement is very great (Ershoff and Deuel, 1944). An investigation of the possible role of the enlarged cecum in adaptation seemed desirable, and is described herein.

MATERIALS AND METHODS

Albino rats from the colony of the Agricultural Biochemistry Laboratory of The Ohio State University or purchased as weanlings from the Sprague-Dawley Company were used. In any one experiment all rats were from the same source, had the same dietary history, and were approximately the same age. Equal sex distribution among groups of rats to be compared with one another was maintained.

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For feeding experiments, rats were kept in individual wire cages with coarse hardware cloth bottoms. Heavy waxed paper beneath the cages caught fecal discharges. The extent of diarrhea was estimated by counting and classifying the number of visibly separate fecal discharges collected on the paper during a 24 hr. period into 2 categories, (1) formed, and (2) soft, including the obviously fluid discharges. The percentage of soft discharges relative to the total number counted was designated as "per cent diarrhea" for that 24 hr. period.

The following diets were fed: *Corn starch diet.* This was the control diet. It contained, per kg., the following ingredients: corn starch, 670 g.; commercial casein, 240 g.; Crisco, 50 g.; U.S.P. XII salt mixture No. 2, 40 g.; choline chloride, 1 g.; inositol, 1 g.; para-animobenzoic acid, 300 mg.; calcium pantothenate, 20 mg.; nicotinamide, 15 mg.; riboflavin, 3 mg.; pyridoxine hydrochloride, 2.5 mg.; thiamine hydrochloride, 2.5 mg.; and 2-methyl-1,4-naphthoquinone, 1 mg. *Other diets.* Diets designated as lactose, cellulose and potato starch diets were prepared by replacing part of the corn starch of the control diet with the desired amount of the corresponding constituent. Cod liver oil was mixed with a small amount of corn starch diet and fed every 7 to 10 days.

To determine the dry weight of cecal tissue of sacrificed rats, gross fat was trimmed away, the colon and ileum were severed at the cecal wall and the opened cecum was washed free of debris in tap water. The tissue mass was oven dried at 105° C for 24 hr., cooled in a desiccator and weighed.

To further elucidate the importance of the cecum in adaptation of the rat to lactose, rats which weighed about 120 g. were cecectomized and an ileocolonic anastomosis was made. In general the methods for intestinal surgery given by Griffith and Farris (1942) were followed. The cecectomized animals appeared normal in 2 or 3 days, exceeded their preoperative weights in 10 days and grew normally until 3 weeks after operation when they were "challenged" with lactose.

RESULTS AND DISCUSSION

Figure 1 shows that the rat's cecum enlarged concomitantly with the feeding of a high lactose diet. Table 1 shows that this cecal enlargement in response to lactose feeding involved an increase in tissue substance (dry weight), and not merely distention of the organ.

To determine the effect of a single variable, size of the cecum, upon the adaptation of the rat to a lactose diet, some way of causing cecal enlargement without feeding the animals lactose was sought. A diet containing 6 percent rice cellulose ("Ruffex") was tested, but it did not cause cecal enlargement. A diet containing 50 percent of raw potato starch was tested also, since raw potato starch has been reported to be only partly digested and to produce bulky feces in the rat and other animals (Baker *et al.*, 1949). Figure 2 shows that this diet produced cecal enlargement in the rat. Table 1 shows that this potato starch-induced enlargement involved an increase both in the fresh weight of the cecum plus its contents and in the amount (dry weight) of cecal tissue. In addition, it was observed that the fecal pellets from the rats fed the raw potato starch diet were large, soft (but well

EXPLANATION OF FIGURES IN PLATE

FIGURE 1. Fresh ceca (including contents) removed from mature rats fed purified diets for 15 weeks, showing enlargement of the cecum in lactose-fed rats. The percentage of lactose in the diet was varied between 30 and 40 percent at different times.

FIGURE 2. Fresh ceca (including contents) removed from rats fed purified diets for one month following weaning, showing enlargement of the cecum in potato starch-fed rats. The potato starch diet contained 50 percent of raw potato starch.

In both figures 1 and 2, the number adjacent to each cecum indicates the body weight in grams of the rat from which the cecum was removed. The scale is indicated on the face of each figure.

Corn Starch
Lactose
245
♀
280
430
♂
375
FIG. 1
♀
136
♂
2

formed) and light tan to white in color. Microscopic examination revealed many recognizable starch grains which turned blue when treated with iodine. No starch could be found in the small, black fecal pellets from the corn starch diet rats. At the end of the conditioning period, the dry weight of feces produced per rat per day was 0.22 g. and 1.75 g. in the corn starch and potato starch groups, respectively; these values represent 2.2 percent and 13.8 percent of the weight of feed consumed per day. Cecal enlargement in the rats fed the potato starch diet probably was due to this large, undigested residue which had to be handled by the alimentary system.

TABLE 1

Effect of feeding various diets upon the absolute and relative weights of the cecum

Time on diets (weeks)	Diet	No. of rats	Body weight (gm.)	Cecal Weights: Fresh, including contents (gm.)	Cecal Weights: Cleaned, dry (mg.)	Cleaned cecum dry weight: body weight ratio (mg./100 gm.)
8	Corn starch	4	267 (232–300)		135 (102–165)	52 (37–70)
8	Lactose*	4	221 (190–240)		186 (165–208)	85 (70–106)
15	Corn starch	2	358 (285–430)		155 (135–174)	44 (40–47)
15	Lactose*	2	328 (280–375)		278 (269–287)	87 (72–102)
4⅛	Corn starch	6	151 (140–190)	2.0 (1.7–2.5)	88 (62–135)	55 (36–72)
4⅛	Potato starch**	6	166 (130–215)	12.5 (9.0–15.1)	218 (160–320)	133 (90–165)

Values given are averages; ranges in parentheses. The individual data are available in Lawrence (1950).

*Percentage of lactose varied between 30 and 40 at different times.

**50 percent in diet.

After sacrificing rats from the potato starch and corn starch groups for the determination of cecal weights reported in table 1, the remaining rats were "challenged" with lactose to see if the enlarged cecum might aid the rat in adapting to a high lactose diet. The schedule of "challenging" with lactose and the results from two separate experiments are given in table 2. This table shows that rats fed lactose diets after being conditioned on the potato starch diet exhibited considerably less diarrhea than did rats fed lactose diets after being conditioned on the corn starch diet. This was true despite the fact that the potato starch-conditioned rats ate comparatively more of the lactose-containing diet, as shown by records of feed consumption.

Because adaptation of the rat to moderate percentages of lactose in the diet usually occurs in 2 to 4 weeks, the control and test groups were compared with one another for only a few days after the "challenge" feeding of the lactose diets was begun. Following the ingestion of lactose the ceca of the controls would be expected to enlarge progressively, approaching those of the test animals in size. A good deal of individual variation was encountered when the lactose level of the

TABLE 2

Diarrheal response of rats conditioned for one month after weaning on starch or potato starch diets, and subsequently fed lactose diets

Experiment	Days on lactose	Percent lactose	Percentage of diarrheal feces from rats conditioned on the diets indicated	
			Corn starch	Potato starch†
A*	0	0	0	0
	1	40	73	75
	2	40	94	66
	3	40	95	79
	4	25	89	60
	5	25	72	0
	6	33	86	27
	7	33	98	44
	8	33	93	57
	9	33	95	36
	Average: (Excluding day 0)		88	49
B**	0	0	0	0
	1	35	74	43
	2	35	71	46
	3	35	93	34
	4	35	91	59
	5	35	90	62
	9	35	83	37
	Average: (Excluding day 0)		84	47

*Six rats, 3 of each sex, in each dietary group.
**Twenty rats, 10 of each sex, in each dietary group.
†50 percent in conditioning diet.

TABLE 3

Effect of cecetomy on the diarrheal response of rats fed lactose

Day of experiment	Lactose fed	Percentage of diarrheal feces	
		Unoperated group	Cecectomized group
0	0	0	0
1	0.4 gm.*	0	34
2	0.78 gm.*	2	47
3	0	0	4
4	0	0	0
5	0	0	0
6	25**	5	78
7	25**	16	99
8	25**	38	100
9	25†	16	95
10	25†	8	95
13	25†	12	92
15	30†	6	99
21	35†	4	84
34	40†	0	89
35	40†	8	93

*Lactose fed, one dose daily, by stomach tube in 2.8 ml. water. All animals kept on corn starch diet for first five days. Feeding 3.0 ml. water by stomach tube caused no diarrhea.
**Percentage in diet of both groups.
†Percentage in diet of cecectomized group. The cecectomized group had been consuming more feed. After the eighth day the unoperated rats were fed a diet five % higher in lactose than the figures show so that they would be sure to ingest as much lactose per day as the cecectomized rats.

challenge diet was finally raised to 50 percent (data not given in table 2). Some rats, whether of the test or control group, adapted, while others (even some of the previously adapted ones) exhibited a severe, unremitting diarrhea. Thus the tolerance built up by the adapted rat may be broken down again in some individuals by raising the lactose level of the ration high enough.

In a further test of the role of the cecum in the adaptation process, the cecum was removed from 7 young rats (5 males and 2 females). Three weeks later these cecectomized rats and seven unoperated controls, all of which had been fed the corn starch diet since weaning, were "challenged" with lactose according to the schedule in table 3. This table shows that the cecectomized rats, when fed lactose by stomach tube or in the diet, passed very high percentages of diarrheal feces compared to the unoperated control rats similarly fed lactose. The table shows also that, on the average, the cecectomized group failed to adapt to lactose in the diet. However, one rat in the cecectomized group did adapt almost completely by the twenty-first day. At necropsy the colon of this rat was found to be fairly large and well-filled with a soft, black fecal mass throughout its length. The colons of most of the other cecectomized rats were almost empty. Possibly hypertrophy of the colon eventually could enable that organ to take over much of the function of the missing cecum.

SUMMARY

1. Albino rats were fed a purified diet containing corn starch as the basal carbohydrate, and other rats were fed the same diet but with 30 to 40 percent of lactose or 50 percent of raw potato starch substituted for part of the corn starch. Compared to the cecum in the corn starch-fed control rats, the cecum in the rats fed the lactose or potato starch diets was enlarged. This enlargement involved not merely distention of the organ by a large cecal mass but also an increase in the dry weight of the cecal tissue.

2. When rats were conditioned for one month on the potato starch or the corn starch diets and subsequently were fed a diet high in lactose, the potato starch-conditioned (large cecum) animals exhibited considerably less diarrhea than the corn starch-conditioned (small cecum) controls.

3. Only one out of seven cecectomized rats adapted (*i.e.*, recovered from the initial diarrhea) during a 35-day feeding period on a dietary regimen involving increasing percentages of lactose. Unoperated control rats adapted almost completely during this period.

4. The size of the cecum appears to be a significant factor in the adaptation of the rat to a high lactose diet.

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SAND AT THE TOP OF THE NIAGARA GROUP AS A SOURCE OF WATER IN WEST-CENTRAL OHIO[1]

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At Harrisburg, Ohio, three wells drilled about 1896 in search of oil or gas struck a prominent water-bearing zone in the limestone bedrock at the depth of about 400 ft. Artesian pressure was sufficient to cause the water level to rise above the land surface and the wells flowed. As reported in 1899 by Edward Orton, Jr., former State Geologist, their total rate of flow was about 850,000 gallons a day. This flow was sufficient, according to Orton, "to run steadily a 9½ ft. water wheel, which is applied to grinding grain, sawing lumber, and the like."

At Plain City the story was largely repeated. Two wells, drilled in 1889 in search of oil or gas, also struck a water-bearing zone in the limestone, in this case at a depth of 397 ft. The water rose 18 ft. above the land surface and the combined flow from both wells was estimated at 2,000,000 gal. day, or nearly 1,400 gal. min. The wells were allowed to flow to waste for a few years, until a waterworks plant was built, after which they became a source of supply for the village.

The most significant fact about the wells at Harrisburg and Plain City, from the point of view of those engaged in developing water resources, was not that the wells flowed, for this is not unusual, but that the yields were so large. When the flowing wells at Harrisburg were drilled they attracted a great deal of attention locally, and the abundant water supply they provided was a prime factor in the establishment nearby of a large State school. The wells have supplied this school for more than 40 yr. The present pumpage, about 500,000 gal. day, is from one of the three wells; the other two are capped. The supply well was test pumped for approximately 8 hr. on October 8, 1946, at rates averaging about 470 gal. min. and drawdown measurements were made. The well was flowing at the start of the test and no determination was made of the water level before pumping started. During the test the water level declined to 26 ft. below the land surface. If the piezometric surface is assumed to have been 10 ft. above the land surface at the start of the test, the total drawdown was 36 ft. and the specific capacity of the well was 13 gal. min./ft. of drawdown.

The original wells at Plain City have been replaced by two other wells of approximately the same depth. The flow from the newer wells is less than the flow reported in 1899 from the original wells, indicating that some diminution of head in the aquifer has occurred over the past 50 yr. The present wells are pumped together most of the time at a combined rate of about 300 gal. min. At this rate of withdrawal water levels in the wells commonly are 3 ft. below the land surface, or less. In the summer, when the demand increases to about 500 gal. min, all the pumping, because of the characteristics of the supply system, is from a single well. This well is equipped with a turbine pump, with the impellers set 45 ft. below the surface. Pumping at Plain City is continuous, for the town has no storage reservoir. Water is pumped directly into the distribution system. In 1953 the average pumpage was 500,000 gal. day.

The large yields from the wells at Harrisburg and Plain City are in sharp contrast to the yields ordinarily obtained from the limestone deposits in central and western Ohio. Most wells drilled into these deposits in search of large water supplies for industrial or municipal use do not yield more than about 100 gal. min. In these days of mounting demand for water it is important to explore all possi-

[1]Publication authorized by the Director, U. S. Geological Survey.

bilities for developing additional groundwater supplies. We should, therefore, examine the facts to ascertain whether the wells at Harrisburg and Plain City represent special cases, involving certain areas where the limestone deposits merely happen to be unusually productive, or whether these wells may have tapped a deep artesian aquifer that may be an important source of water in west-central Ohio. At least superficially, the latter view seems to receive support from the fact that the wells at Harrisburg and Plain City were drilled to elevations substantially lower than those commonly reached by wells in the area. An examination of the problem must begin with the geology.

GENERAL GEOLOGY AND HYDROLOGY

The bedrock beneath the glacial and alluvial deposits in most of central and western Ohio is formed by limestones and dolomites of Silurian and Devonian ages. These carbonate rocks underlie the area in the form of a relatively smooth plane, which is interrupted by buried valleys where the rocks were cut through or trenched deeply by streams of former drainage systems. Along an east-west line passing through Columbus and Springfield, the general level of the bedrock surface declines in elevation from about 1,000 ft. above sea level in western Clark County to about 850 ft. above sea level in western Franklin County. The strata dip gently to the east, away from the crest of the Cincinnati anticline. The angle of dip, as well as the thickness of the beds, become greater in an eastward direction as the rocks descend into the Appalachian basin. In the aggregate, the carbonate rocks range in thickness from 200 ft. or less between Dayton and Piqua, in western Ohio, to more than 800 ft. in the central part of the State in the area between Columbus and Delaware. The major units of the carbonate rocks, beginning near the base of the Silurian system, are: the Brassfield limestone; the Niagara group which, in west-central Ohio, includes the Osgood shale, the Euphemia dolomite of Foerste (1935) the Springfield limestone, and the Cedarville [2] dolomite; the Bass Island dolomite of the Cayuga group, called in older reports the "waterlime" or lower Monroe; and the Columbus and Delaware limestones of Middle Devonian age.

All the rock units named above, except the Osgood shale, are excellent sources of ground water for farm and domestic use. In many places they are also good sources of water for industrial or municipal use. In general, the carbonate rocks above the Osgood shale constitute a single aquifer within the depths commonly reached in drilling. Some beds locally are more permeable than others, either because of their structure or because they are more fractured or jointed, and yields of wells range over wide limits. Relatively permeable zones may occur along bedding planes or at disconformities between the major rock units. Changes in permeability also may result from facies changes. Many of the permeable zones are persistent over wide areas and may, in effect, constitute semi-independent aquifer systems, even though locally they may be hydraulically interconnected with the entire rock sequence in which they occur. The present evidence, illustrated by the results of drilling at Harrisburg and Plain City, shows that there is a highly permeable zone in the carbonate rocks in western Franklin County and surrounding area below the depths commonly reached in drilling. Wells drilled to this zone encounter it at progressively lower elevations from west to east, and the rate of decline in elevation of this permeable zone is approximately equal to the regional dip of the strata. Generally this permeable zone has been overlooked by drillers because of its relatively great depth. It appears to be of potential importance in some areas as a source of water for large-scale industrial or municipal use.

[2] Formerly called Guelph dolomite.

NEWBURG SAND (?) ZONE OF DRILLERS

The permeable zone in the carbonate rocks that supplies the flowing wells at Harrisburg and Plain City is at or near the top of the Niagara group. Orton (1899, p. 660) refers to these wells as:

> "examples of excellent supplies of water derived from the porous or Guelph division of the Niagara limestones."

Stratigraphically, the zone appears to lie at the horizon of the Newburg sand zone of drillers. The Newburg is named from the Newburg, or Newburg Heights, district in the southeast part of Cleveland, where the stratum formerly yielded gas at depths ranging from 2,300 to 2,600 ft. According to Stout (1935, p. 307):

> " the so-called sand is generally impure, porous dolomite, varying from light gray to pink in color. Locally the horizon contains thin lenses of sandstone, evidently deposits left along a line of disconformity. The position of the Newburg sandstone is variable, but commonly it is found 150–200 feet above the base of the "Big lime". Stratigraphically, the deposits are interpreted to lie near the contact between the Salina formation[3] and the underlying Guelph dolomite. The thickness of the Newburg sand ranges from 1 to 30 feet. . . This also is one of the chief water-bearing horizons in the deep seated rocks. The flow is so great that it is known to the driller as the "Big water" in the "Big lime." It is sometimes referred to as the "Second water."

It is significant that the Newburg, which lies under deep cover in the eastern part of the State, is generally noted for its water-bearing properties. Judging by its widespread occurrence, the high permeability of this "sand" seems to be of inherent nature and evidently is characteristic of the stratum, generally. For this reason the Newburg sand (?) zone of drillers should be traceable as a water-bearing stratum over much wider areas than those in which it is now recognized, perhaps to its outcrop area in western Ohio. Data are few, unfortunately, in the area intervening between the oil and gas fields of eastern Ohio and the outcrop area of the Niagara group, and the general continuity of the Newburg as a zone of high permeability cannot be established with certainty on the basis of the present evidence. However, the evidence points to the probability that it is continuous.

On the basis of the meager data available, a map (figure 1) has been drawn showing contours on the Newburg sand (?) zone of drillers in the western half of Franklin County and the surrounding area. The map shows the Newburg to range in elevation from more than 500 ft. above sea level in the western part of Franklin County to 100 ft. above sea level in the central part of the county. The elevation of the Newburg is 528 ft. above sea level at Plain City, and 392 ft. above sea level at Harrisburg. The dip of the zone is about 25 ft./mile, or about the same as the regional dip. The zone is reached at depths ranging from about 350 ft. in lowland areas along the principal streams in the western part of Franklin County to about 500 ft. in similar areas in the central part of the county. Data on which the accompanying map is based include, besides the records of the wells at Harrisburg and Plain City, the records of six other wells. A show of water, a facies change, or a change in drilling characteristics was reported in each well at or near the depth of the Newburg. Pertinent information from the records of these wells, which are identified by name on the map, figure 1, is summarized as follows:

Riebel well—drilled for oil or gas in 1922 on the Charles Riebel farm near Georgesville. The driller reported a soft zone in the limestone between depths of 355 and 360 ft., the estimated elevation (510 ft. above sea level) of the Newburg.

Grove City well—drilled at the village waterworks in 1954 to a depth of 472 ft. The well probably bottomed within about 50 ft. of the Newburg, which is estimated to lie at an elevation of about 330 ft. above sea level. The drillers re-

[3]Basal formation of the Cayuga group.

ported striking a large cavity or fissure in the rocks at the bottom of the well. When the cavity was struck, the water in the well abruptly rose about 20 ft. above its former level. The well was test pumped at the rate of about 450 gal./min. The specific capacity after 12 hr. was 17 gal./min./ft. of drawdown, appreciably greater than the specific capacity of any of the other wells in the village well field.

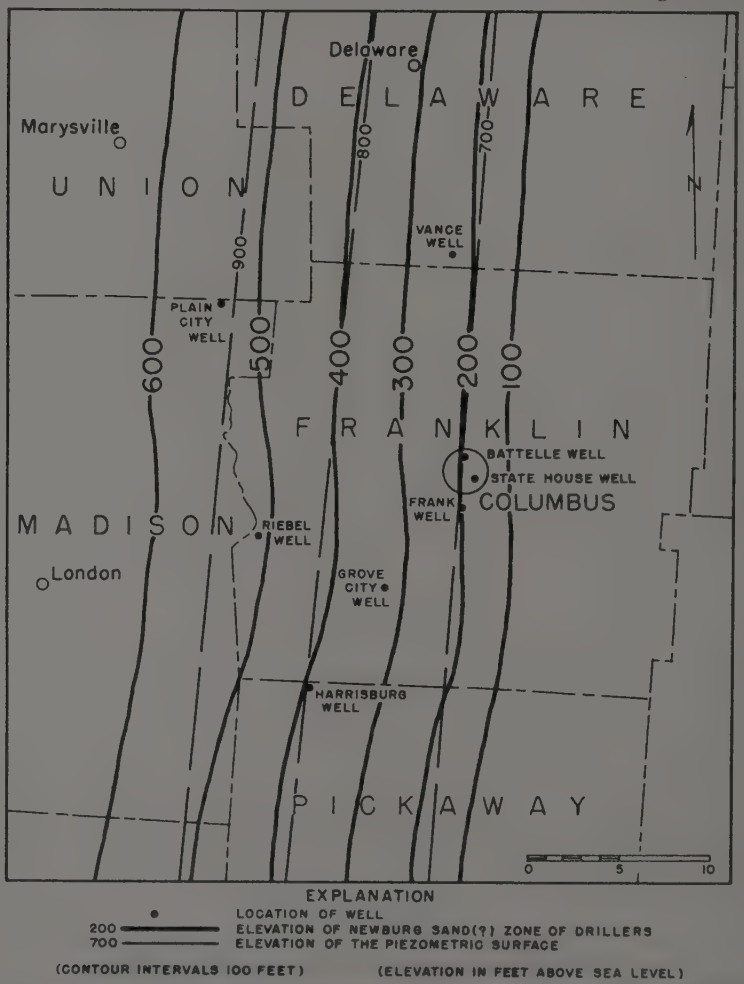

FIGURE 1. Map of a portion of west-central Ohio showing contours on the Newburg sand(?) zone of drillers and the piezometric suface in wells drilled to this zone.

Because of the poor quality of the water the 472-foot well was subsequently plugged at the depth of 348 ft., after which it was again test pumped. The specific capacity after 12 hr. was 6.5 gal. min. ft. of drawdown, indicating the major part of the yield during the previous test to have been from the deeper strata.

Vance well—drilled for oil or gas on the Herman E. Vance farm, Orange Township, Delaware County, 1937. The Newburg sand (?) zone of drillers is reported by Stout and Lamey (1940, p. 675) to lie at the depth of 690 ft, or at the elevation of 230 ft. above sea level.

Frank well—drilled for oil or gas in 1890 on the George C. Frank farm, about 2 miles south of Columbus. According to reports, drillers hit water at "about 500 feet" and the well flowed open for many years. At this location the depth of 500 ft. would be about 200 ft. above sea level, the estimated position of the Newburg.

State House well—according to Orton (1888, p. 107) a well drilled for water in Columbus at the State House during the period 1857 60 was reported to have struck "salt water" at the depth of 675 ft. This depth is at the elevation of 190 ft. above sea level, the approximate position of the Newburg.

Battelle well—test well drilled by the Battelle Memorial Institute, Columbus, Ohio, in 1954 for the purpose of testing drilling methods and equipment. At this site the elevation of the Newburg sand (?) zone of drillers is estimated to be about 200 ft. above sea level, or somewhere near the depth of 520 ft. The drillers did not report a show of water at this depth and there is no mention in the drilling log of substantial mud loss in this part of the hole, which, had it occurred, would have been an indication of greater than average permeability. However, the rocks between the depths of 500 and 560 ft. contained an abundance of gypsum and anhydrite. Drill cuttings revealed especially prominent anhydrite zones between the depths of 500 and 510 ft., and between the depths of 530 and 560 ft. Within these zones the rocks consisted of 30 percent to 50 percent anhydrite, reflecting abrupt lithologic changes in the normal dolomite sequence. It is probable that these lithologic changes are illustrative of stratigraphic conditions which locally may produce radical differences in the character of the Newburg.

Where the Newburg sand (?) zone of drillers is associated with an abundance of secondary minerals, as it is in the area of the Battelle well, it may be of lower than average permeability. The mineral constituents, in this case anhydrite, may occupy most of the voids within or adjacent to this zone and cause the water which ordinarily is present to follow other paths. These alternate paths may occur as discrete zones either above or below the Newburg, but they are hydraulically connected with, and in a sense are "fed" by water from the Newburg. Evidence of such conditions is provided by the record of a well, not shown on figure 1, that was drilled for oil or gas in 1886 at the Wassall Sewer Pipe Works, located about a mile south of the Battelle well and at about the same elevation. The well at the pipe works was reported by Orton (1888, p. 282) to have yielded sulfur water from the depth of 573 ft. Orton thought this marked the top of the Niagara group, but this interpretation is inconsistent with the sections observed in the other wells whose records are reported herein. The writer believes, therefore, that Orton's interpretation is incorrect and that the water reported at the depth of 573 ft. in the Wassall Sewer Pipe Works well came from rocks at least 50 ft. below the top of the Niagara group. The drillers reported "gypsum in quantity" at the depth of 550 ft., which is substantially the same elevation as the lower of the two prominent anhydrite zones discovered in the Battelle well. With final reference to this point, it seems probable to the writer that at Grove City the Newburg sand (?) zone of drillers was the source of water found in the lower part of the 472-foot well, even though this well was several tens of feet short of actually reaching the stratum.

Recharge to the Newburg in the eastern part of the State, where it is deeply buried, probably comes principally from the surrounding rocks. Some of the water in this zone may be connate water, trapped in the rocks at the time of their deposition. In west-central Ohio, near the outcrop area of the Niagara group, recharge to the Newburg probably is derived mostly from seepage through the glacial deposits in areas where they directly overlie this permeable stratum. The

Newburg crops out beneath the glacial drift in wide areas in Madison County and eastern Clark County where the consolidated rocks are deeply trenched by the buried Teays Valley. It is probable that in this buried valley area the Newburg receives the major portion of the recharge which sustains the wells at Harrisburg and Plain City. Evidence for this lies in the fact that the piezometric surface in wells drilled to the Newburg occurs at progressively higher elevations from east to west and merges with the regional water table a few miles west of Plain City. The piezometric surface in wells drilled to the Newburg slopes eastward from the recharge area at a rate averaging somewhere between 15 ft. and 20 ft. mile, the slope reflecting the loss in head as the water moves down the dip of the stratum. The general elevation of the piezometric surface ranges from about 900 ft. above sea level along the Madison County-Franklin County line to about 700 ft. above sea level at the Frank well in the central part of Franklin County. Flowing wells from the Newburg sand (?) zone of drillers in Franklin County thus are restricted to lowland areas.

TABLE 1

Analyses of water from the Newburg sand(?) zone of drillers at Harrisburg, Plain City, and Grove City

Chemical constituents (parts per million)	*Harrisburg* (2–16–55)[1]	*Plain City* (2–15–55)	*Grove City* (10–23–54)
Silica (SiO_2)	15	11	10
Iron (Fe)	.37	.75	.36
Manganese (Mn)	.00	.00	.00
Calcium (Ca)	134	143	424
Magnesium (Mg)	48	52	124
Sodium (Na)	35	19	51
Potassium (K)	3.4	3.5	5.8
Bicarbonate (HCO_3)	389	420	316
Carbonate (CO_3)	0	0	0
Sulfate (SO_4)	239	235	1,220
Chloride (Cl)	23	12	84
Fluoride (F)	2.1	1.7	2.3
Nitrate (NO_3)	.2	.2	.4
Dissolved solids (residue on evaporation at 180 C.)	720	724	2,230
Hardness as $CaCO_3$:			
Calcium, magnesium	532	573	1,570
Noncarbonate	213	226	1,310
Specific conductance (micromhos at 25° C.)	1,050	1,040	2,460
pH	7.4	7.2	7.0
Color, units	5	5	3
Hydrogen sulfide (H_2S)	.1	.5	3.6

[1]Date of collection

QUALITY OF THE WATER

The most serious limiting factor imposed on the use of water from the Newburg sand (?) zone of drillers in most areas is its poor chemical quality. More than a few miles east of the recharge area the water is mineralized to the extent that it is generally unfit for most purposes. Present evidence shows that the dividing line between areas where the water from the Newburg is of generally satisfactory quality and areas where the quality is decidedly inferior may lie somewhere in west-central Franklin County. At best this is a generalization, for in all probability this hypothetical line is subject to much variation in position.

The quality of the water from the wells at Harrisburg and Plain City is essentially similar, and is within the common range of waters from a limestone region. At Grove City the quality is quite different, for there the water from the Newburg is so highly mineralized and hard that it is unfit for most purposes. A comparison between these waters is shown in the following table, based on recent analyses made by the U. S. Geological Survey, Columbus, Ohio.

The chief chemical constituents in the water from the Grove City well are calcium (Ca) and sulfate (SO_4), probably derived from anhydrite deposits, particles of which were detected in the drill cuttings from the well.

Anhydrite, or calcium sulfate ($CaSO_4$), occurs at various places in Ohio. It is commonly interbedded in the lower part of the dolomitic limestones of the Cayuga group, and it occurs to some extent in all the carbonate rocks. Deposits of anhydrite generally are in close association with deposits of gypsum which has the same chemical composition but contains water of crystallization ($CaSO_4 \cdot 2H_2O$). Generally these calcium sulfate deposits are of small extent. Deposits of proved economic value are found at only two localities in the State, on the north and south shores, respectively, of Sandusky Bay.

Anhydrite and gypsum deposits are so highly variable in their distribution and continuity that it is virtually impossible to predict their occurrence locally in advance of drilling. In describing the gypsum deposits at a quarry near Sandusky Bay, Bownocker (1920, p. 220) reports as follows:

> ". . . in some localities the beds can not be correlated with those shown in sections a short distance away. Within a few rods gypsum may be reduced one-half in thickness and in places it is cut out entirely."

Anhydrite occurs at or near the Newburg sand (?) zone of drillers in north Columbus and traces of this mineral were found at Grove City in the rocks above the Newburg. The anhydrite deposits associated with the Newburg may be of general occurrence in the central part of Franklin County.

Hydrogen sulfide (H_2S) may also relate to the calcium sulfate deposits and if so this may account for the high concentration of this constituent in the water from the Grove City well. It is thought that hydrogen sulfide may be produced by reduction of sulfate.

SUMMARY AND CONCLUSIONS

The main points of interest revealed by the present investigation are:

1. An apparently widespread zone of relatively high permeability occurs in the carbonate rocks in Ohio at or near the top of the Niagara group, at the horizon of the Newburg sand (?) of drillers. In western Franklin County and surrounding areas the Newburg is below the depths commonly reached in drilling and for this reason it has been generally overlooked as a source of water.

2. Yields from the Newburg far exceed yields commonly obtained from wells drilled generally into the limestone deposits. Supplies at least in the magnitude of 0.5 mgd to 1 mgd probably are available from the Newburg at many places in west-central Ohio.

3. Recharge to the Newburg in west-central Ohio occurs principally in areas where the stratum crops out beneath permeable glacial deposits. Recharge conditions probably are most favorable in buried-valley areas where the stratum crops out in the valley walls adjacent to saturated permeable valley fill of glacial origin.

4. The quality of water from the Newburg in areas relatively close to its outcrop is fairly typical of limestone waters generally, except where the rocks are interbedded with calcium sulfate deposits. The presence of calcium sulfate results in water of inferior quality, which may be unsatisfactory for most purposes. Calcium sulfate in the water may not be detrimental for some uses where large quantities of water are needed, such as for supplemental irrigation.

The meagreness of the data on which this report is based, and the potential importance of the Newburg sand (?) zone of drillers as a source of water for large-scale use, make it essential that more be learned about the water-bearing properties of this stratum. Test holes are needed to determine accurately the thickness and physical properties of the Newburg. Its position in the stratigraphic column must be better defined for purposes of correlation. The outcrop areas of the Newburg should be mapped and related to the shape of the regional water table. This relationship may reveal the areas that furnish the most recharge to the stratum, and if so, would be of aid in locating supply wells to best advantage.

Information on the quality of water available from the Newburg obviously is needed, both to delineate the areas locally where the water may be of poor quality and to define in regional terms the general limits of the area in which the aquifer may be expected to yield potable water.

Controlled pumping tests are needed to determine in quantitative terms the water-bearing properties of the Newburg. It may be possible to map areas of differing permeabilities and to define these areas in terms of probable long-term yields of wells. It would also be important to determine whether intensive development close to areas of recharge may result in up-dip migration of mineralized water which may now be kept down dip by recharge.

A preliminary program of test drilling and testing need not be unduly expensive. It could be supplemented by a more comprehensive program if the initial results were favorable. Such a program might prove of great economic value in the years ahead.

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Organic Insecticides. Their Chemistry and Mode of Action. *Robert L. Metcalf.* Interscience Publishers, Inc., New York. 1955. x + 392 pp. $8.50.

This book, addressed to organic and biochemists, entomologists, and toxicologists, has been written by an expert qualified in all these fields. It presents in a single volume a comprehensive coverage of the organic chemistry, insect and mammalian toxicity, relation of structure to toxicity, mode of toxic action and of detoxification of organic insecticides, both synthetic and natural. In addition there are chapters titled: "Joint Action of Insecticides" and "Insecticide Resistance".

While fully documented with references listed at the end of each chapter (about 29 pages total of reference lists), *Organic Insecticides* is much more than a compilation of data. It is rather a well organized, readable discussion which will be meaningful alike to the organic chemist, applied entomologist, and toxicologist, although each will read it from a different viewpoint. The book is also directed to students, but the less-advanced student without a fair background in both chemistry and entomology will find it heavy going. For the advanced student it offers the basis and stimulus for future achievements.

Proofreading this volume must have been a herculean task for about half the pages of the text are interspersed with diagrams of structural formulae, chemical reactions, or tabular material. There are 70 numbered tables plus some unnumbered ones. The reader is supplied with both structural formulae and exact chemical names for most of the materials discussed.

A 16-page index completes this excellent treatise.

FRANK W. FISK

SALINITY DATA ON MARINE AND INLAND WATERS AND PLANT DISTRIBUTION

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In October, 1952, the editor of the Hand Book on Biological Data, Dr. E. C. Albritton, wrote me a letter in which he said ' on the strength of several recommendations I am writing to ask you to prepare certain tabular data which are urgently needed for the Hand Book." The Hand Book, as most biologists know, is a reference work published by the American Institute of Biological Sciences and which is associated with the National Research Council in Washington, D. C.

Dr. Albritton went on to say that these data were needed in connection with studies on the general subject of tolerances of representative water-inhabiting plants to salt concentrations. This request came to me because of certain studies I had made in connection with salinity tolerance in the estuaries of streams entering the Gulf of Mexico and Long Island Sound, Bowman (1916, 1917, 1918). Accordingly, I went over my notes made in those waters almost 40 yrs. ago, and with extensive consultation of more recent work by other investigators, I was able to send the tables requested to the editor in Washington in the spring of 1953 in a preliminary form. In March, 1955, we had corrected the proof of the Condensed Table on Characteristics of Natural Salt Waters, and it is now ready when the new Edition of the Hand Book appears.

Since the tables are so condensed, the explanation of the data might well be enlarged into a short article. In the relationships of certain plants to the bodies of water discussed, this paper is therefore an expansion of the material represented in the table which necessarily could not include reference to plant species and other pertinent facts involved.

As a fundamental statement for this article, it may be observed that the water of the oceans of the world are remarkably constant in their chemical composition. It is the variation in salinity which is the subject discussed here.

Sea water is normally alkaline with a pH between 7.5 and 8.8. In bays where plant life may deplete the carbon dioxide or in enclosed areas of the ocean, as tidal pools where hydrogen sulphide is generated, the pH may fall to neutrality or even become acid. When the pH rises above 9.0, magnesium hydroxide and calcium carbonate are precipitated out of solution. Table 1 gives the average composition of sea water according to Mason (1952).

Salinity is defined as the total weight of dissolved solids in 1 kg. of sea water. Chlorinity is defined as the amount of grams of precipitated halides (Cl, Br, and I) as determined by precipitation with a silver salt from 1 kg. of sea water. Salinity can be calculated from the chlorinity or determined by the density of samples. They are expressed as g./kg. or parts per thousand o/oo.

In the open sea the salinity averages 35 o/oo and in all sea water the relative proportions of the various ions is constant. The standard chlorinity is 19. and all other constituents may be calculated from this constant. There are no significant regional variations in sea water.

The salinity also varies with temperature. As stated by Coleman (1950), temperature of the surface layers of the ocean is 30° F plus and the winter temperature 18° F.; the corresponding salinity 34.32 o/oo to 35 o/oo. Whereas the deeper water of the ocean with a winter temperature 21.5° to 22° F. may be 35 o/oo-37 o/oo. The abysmal depths with very low temperature 4° to 1° F. and pressure may reach a salinity of 40 o/oo–41 o/oo. The coldest and densest water on earth is

formed under the Antarctic Ice Cap. It is called Antarctic Bottom Water since due to its weight it sinks and then creeps over the ocean floor. It is the bottom layer of almost all the main ocean basins.

The Arctic Ocean's Bottom Water is not so dense nor so cold as the Antarctic due to greater melting of polar ice in summer and the large volumes of fresh water from the Siberian rivers.

The salinity of the surface waters of the oceans varies with latitude to slight but appreciable degrees. The salinity at the equator is 35. Bordering this, in both hemispheres, is a belt with a salinity of 36. In the N. Hemisphere this belt is between the 20th and 40th parallels of latitude. In the S. Hemisphere it lies between the 10th and 30th parallels. Beyond these belts the salinity gradually decreases so that the 60th parallel N. Lat. it is 31 and at the 60th parallel S. Lat. it is 33. These variations of the surface salinity are due to metorological conditions. In equatorial regions there is less wind, excessive rains and high temperature all causing a moderate salinity. In the belts the fairly high temperature induces evaporation but it is enhanced by strong trade winds and less rain so the

TABLE 1

Composition of average sea water. Ion Cl. 19‰

	Salinity	Percent
Cl.	18.980	55.04
Br.	0.065	0.19
SO	2.649	7.68
HCO_3	0.140	0.41
F.	0.001	0.00
H_3BO_3	0.026	0.07
Mg.	1.272	3.69
Ca.	0.400	1.16
Sr.	0.013	0.04
K.	0.380	1.10
Na.	10.556	30.61
Total	34.482	99.99

salinity is highest here. Towards the poles the salinity gradually decreases due to the decrease in evaporation and temperature and to the dilution caused by melting snow which by its low density tends to remain on the surface. Table 2 as published by Marmer, (1930), shows the salinities of special areas of the ocean.

The Red Sea's salinity is due to high temperature, great evaporation and little addition of fresh water. On the other hand the Gulf of Finland is almost fresh water due to the large volume of precipitation and fresh waters poured into it. At the mouth of the Amazon the ocean water is potable for 100 mi. off shore, and off the Siberian Coast the Dwina, Obi, Mezen and other rivers keep the salinity down to 25.

PLANTS IN THE SEA AND THEIR DISTRIBUTION

No plants of the Seed-plant group occur in the deep oceans. However, about 30 genera of Seed-plants live in the oceans fairly close to shores and at depths of 10 to 40 ft. depending upon the light penetration of the water. These genera fall into two families according to Sverdrup (1942); three in the Family Hydrocharitaceae and six in the Family Potamogetonaceae. In the former family I have found *Halophila* of two species in 40 ft. of extremely clear water in the Gulf of Mexico, where the bottom of white coral sand reflects light and gives these delicate green plants sufficient light for photosynthesis, Bowman (1916). In more shallow

water, 6 to 10 ft. *Thalassia* and other submerged aquatics thrive, Bowman (1917). *Zostera*, the Sea Grass, is almost world wide in distribution on shallow and muddy shores of oceans. Its close relative, *Phyllospadix*, is abundant on wave washed coasts of Europe and in Denmark it provided almost the sole food for a number of marine animals.

The most conspicious plant life of the sea is, of course, the algae, as I indicated in collections made in Tortugas, Bowman (1918). These live along the continental shelves and are in greatest abundance near the mouths of rivers.

The Myxophyceae or Blue Green Algae are not too well represented in salt water but *Nodularia spumigera* makes the quiet Norwegian fiords slimy with abundant surface growth. *Trichodesmum erythraeum* is a blue-green alga which at certain seasons produces abundant carotene and turns the Red Sea and other marine ocean surfaces a bright red color.

The Chlorophyceae or Green Algae thrive where there is a mixture of fresh and salt water. *Enteromorpha* and *Ulva*, the Sea Lettuce, are common sights in all harbors of the temperate zones, but are restricted to 10 m. in depths. In tropical waters along shallow shores the calcareous algae *Codium*, *Halimeda* and many others abound. But off shore no great quantity of green algae is found in deep water.

TABLE 2

Salinities of certain special ocean areas

	Parts per Thousand
The Baltic Sea and North Sea of Denmark	30
The N. Pacific is uniform at	36
The Gulf of Mexico, West of Australia and Carribean Sea	36
The S. Pacific off the coast of Peru reaches	36.5
The Persian Gulf to the equator	37
The Sargasso Sea in the N. Atlantic	38
Off Brazilian Coast in the S. Atlantic	38
The Red Sea the highest salinity of all oceans	40–41

The Phaeophyceae or Brown Algae are very abundant along all coasts, especially on rocky shores, but more sparsely in brackish water. The Rock weeds *Fucus* and *Ascophyllum* are the common genera. The Kelps of the Atlantic like *Laminaria* and the *Nereocystis* and *Postelsia* or Sea Palm on the Pacific rocky shores are common. Some live at a depth of 15 to 20 m. The Sargasso weed is characteristic of the Central Atlantic where it lives in immense floating masses resembling islands which gives its name to that area called the "Sargasso Sea." Almost all Brown Algae are attached to some stationary object but *Sargassum* can grow vegetatively in floating masses.

The Rhodophyceae or Red Algae, are the only ones that live beyond the continental shelfs. They can live at greater depths than any other marine algae and many forms such as *Corallina* deposit calcium carbonate in their bodies. Their stiff limy remains are of geological significance. Most of the Red Algae are small forms and may live at a depth of 30 m.

Diatoms are minute algae which are universally distributed in all oceans and in fresh water. They constitute the most important item in marine plankton. Square miles of ocean may be covered with diatoms which gives the surface a soupy appearance. Another group of algae are the *Halosphaera*, these also are items of plankton. They are found in the Atlantic, Antarctic and the Mediterranean. The *Coccolithophores* is another group of Yellow-green Flagellates that

contribute largely to marine plankton. *Coccolithos pelagicus* is in this class; it has tiny calcareous plates but is small enough to pass through silk nets. It is found in all oceans except the extreme polar seas. In summarizing the algae it may be stated that all algae are located in the upper 100 m. of the open sea due to the lack of light below this depth. In the muds and oozes on the ocean floors only bacteria are found. Here these low plants abound and are relatively less abundant in the upper strata of water. Thus the major forms of plant life in the open sea are microscopic in size, diatoms, Dinoflagellates and Coccolithophores.

SALINITIES OF ENCLOSED OR INLAND BODIES OF WATER

In arid regions with only small precipitation the weathered components of the rocks remain in the soil or are transported to depressions of the terrain, as pointed out by Rankama (1950). The dry air and rapid rate of evaporation do not allow much water accumulate. The great quantity of dissolved minerals finally produces salt lakes or so called "alkali" pools; with further evaporation

TABLE 3

Types of saline lakes

1—Chloride Lakes in which the chief salt is sodium chloride derived possibly from the ocean.
2—Bittern Lakes—rich in magnesium salts.
3—Sulphate Lakes—rich in sulphur compounds.
4—Carbonate and Bicarbonate Lakes—rich in these salts.
5—Alkaline Lakes—which mostly occur in volcanic areas of the earth while the preceding saline lakes occur in areas of sedimentary rocks.

the lakes may turn into dry salt beds. Basins which have rivers flowing into them but which have no outlets become concentrated solutions of salt water but of a very different composition than sea water. The chief salts that can be precipitated from such water are the sulphates of sodium, magnesium and calcium with some bicarbonate. The Caspian Sea is the largest of such salt lakes in the world with salinity 150 o oo. Others are the Dead Sea, salinity 350 o oo, Great Salt Lake in Utah, salinity 243 o oo, and Searles and Owens Lakes in California. These salt or "alkali lakes" are chemically classified in table 3 dependent on their composition.

The Dead Sea is an example of a Bittern Lake. Its water is low in sodium but high in magnesium. Its main feeder is the River Jordan. Its water also contains some bromine which is supposed to be derived from hot springs in the bottom of Lake Galilee– as 2 g. of Br ton of water occurs in the Jordan River. The salinity of the Dead Sea is ten times that of the ocean *i.e.* about 350 o oo or about 30 percent of salts.

Searles Lake in the Mohave Desert of California is now almost dry. It represents almost solid lithium phosphate. This lake furnishes nearly half of the world's supply of lithium. Its brine contains 0.085 percent of bromine and the sulphate, carbonate and bromide of sodium, potassium sulphate and borax. Half of the world's total output of borax comes from Lake Searles. Near it is Owens Lake which is fed by Owens River and is much more liquid than Searles Lake. This lake is the source of sodium carbonate and borax.

Great Salt Lake in Utah is the area of a former great inland lake called Lake Bonneville. It is fed by streams flowing over sedimentary rocks and the analyses of these streams show them to be normal river water in which carbonates predominate—but the water of Great Salt Lake is laden with sodium chloride derived from the rocks of its basin. However, compared with sea water, Great Salt Lake has a salinity 7 times greater.

Its general composition is similar to sea water except that it is lower in mag-

nesium and higher in sodium content. Since its brine cannot hold carbonate in solution there are no carbonates in the water of Great Salt Lake. Its composition is given in table 4, according to Rankama (1950).

Flora of the Great Salt Lake was described in 1934 by Flowers. The water of this lake is clear and transparent resembling fresh water. At some places masses of algae in local colonies may give the water a brownish color. There are no emergent plants in the Lake except at bays where fresh water enters. The high salt content is toxic for most plants and the main body of water contains only algae of two groups, four in the Myxophyceae or Blue-Green Algae and two in the Green Algae or Chlorophyceae. The former are *Aphanothece, Microcystis* and two species of *Oscillatoria;* in the latter are *Chlamydomonas* and *Tetraspora.* Only three types of animal life live in the Lake water, a brine shrimp and two species of Salt Fly larva. These feed on the algae. There are no trees

TABLE 4

Salinity of Great Salt Lake

	Percent
Cl.	55.48
SO_4	6.68
CO_3	0.09
Na.	33.17
K.	1.66
Ca.	0.16
Mg.	2.76
Fe_2O_3	—
Al_2O_3	—
SiO_2	—
Salinity	243 o/oo

on the Lake borders and salt flats but a few grasses, weeds and succulent herbs are found here as two species of Salt wort, *Salicornia; Allenrolfea,* the Ink weed; *Suaeda* or Salt Blite and Salt Grass, *Distichlis.* Near fresh water inlets occur numerous marsh plants and other algae, mosses and lichens.

SMALL ALKALI POOLS AND ALKALI SOILS

Like the Salt Lakes and large inland basins these pools or so-called "alkali soils" contain salts of a very different proportion than the ocean. In arid regions with poor drainage the small bodies of water become highly laden with the soluble salts of the native rocks. However, these salts are not always alkaline in the chemical sense. The high concentration of even neutral salts is toxic to plant growth. These salts may be chlorides, sulfates, carbonates or nitrates of sodium, potassium and magnesium and the chlorides and nitrates of calcium. Even sodium nitrate used as a fertilizer may form an "alkali soil," if in excess. Soils full of neutral salts should more properly be termed "saline soils." All of the above salts named are neutral except the carbonates of sodium and potassium.

When the soils full of neutral salts evaporate a white crust appears on the soil or at the edges of pools. This is called White Alkali Soil. The carbonates of sodium and potassium due to their solvent action on organic matter turn the soil dark brown or black. These soils are called Black Alkali Soils. The hydrolysis of this sodium and its reaction with carbon dioxide will form sodium carbonate in the soil and render the soil completely unfit for plant growth.

Plants that will grow in saline soils are *Salicornia* or Salt Wort, *Suaeda* or Salt Blite and *Atriplex* or Orach—where the soil is white encrusted. In 16 states of the western area of the United States, saline soils are hindrances in agriculture. Near Lincoln, Nebraska, the sodium chloride may reach 2.3 to 1 percent of the

dry weight of soil in summer. At Great Salt Lake the soil on the shore flats reaches 5.0 to 6.5 percent salt of dry soil weight, according to Weaver (1936).

Black Alkali soils full of carbonates of sodium or potassium form NaOH or KOH which renders the soil basic and prevents all growth but a few halophytes. Alfalfa will tolerate a 300 times greater concentration of magnesium sulphate if a little calcium sulphate is present. In general, calcium seems to mitigate the toxicity of the other ions except in the Black alkali soils. Most plants will tolerate a saturated solution of calcium sulphate but even a very dilute solution of copper sulphate is toxic. Toxicity is believed to be due to the destruction of enzymes in protoplasts when salts are absorbed. In rainy seasons plants can grow in saline soils when the salts are diluted by the rain and carried below the root zones. At White Sands, N. M., the soil is so concentrated in calcium sulphate that only two species of plants can grow there—*Allenrolfea*, the Ink weed and *Abronia* the Sand verbena, as listed by Daubenmire (1947).

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There is a need in this country for a geological text that includes both physical and historical geology, for use in one-term college courses intended to cover the elements of the science. With one exception, American texts of this sort are wordy, or obsolete in thought, or addressed to students who like to memorize, but resist mental exercise. Our texts are anthropomorphic or lack any coverage of some of the major concerns of geology such as isostasy or continental drift. This British text fills the need without any of these drawbacks. The author is a Reader in Geology at the University of London.

This book has seven sections and two appendices. Section one covers the development and scope of the science of geology. The second is concerned with "basic principles": stratigraphy and structure. The third deals with weathering and gradational processes, wherein insolation is described as an important weathering process, and the author follows the Davisian concepts of stages of stream erosion. The treatment of glaciology is rather short, but there is a good discussion of periglacial effects. The fourth part, on petrology and mineralogy, includes elementary crystallography, good tables for mineral identification, the use of the petrographic microscope with abbreviated tables, and an extensive section on hand-specimen petrology and economic uses of rock products. The fifth, on the composition and origin of the earth, includes a review of earthquakes and the interior of the earth, isostasy, orogenesis and convection currents, and continental drift. The sixth part, on historical geology, treats of the time scale (wherein only European orogenies are listed), fossils and organisms with an illustrated taxonomy of invertebrates and very abbreviated description of vertebrate and plant groups, evolution, and a brief geologic history of the British Isles. The last section is on economic geology and includes water supply, engineering applications of geology, non-metallic resources, oil geology, and subsurface methods. The study of topographic maps and suggestions for further reading are the two appendices.

An outstanding advantage of this text is the brief but very extensive treatment of geology: a nucleus adaptable to a variety of course plans and a wide range of course content. Some may object to the fact that most examples and illustrations are from the British Isles, but these are not of themselves objectionable, and the lecturer can of course freely adduce examples and illustrations from North American geology.

MALCOLM P. WEISS.

A BIOCLIMATIC LABORATORY IN SOUTHERN OHIO[1]

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The role of microenvironments in accounting for certain aspects of the distribution of plants and animals, as well as in the interpretation of the biotic histories of areas, and the analysis of the dynamics of biotic communities is not an inconsiderable one. Moreover, their relationships to general weather and macroclimate are important in applied aspects of ecology, including forestry, conservation, agronomy and the like.

Early approaches to local variations in weather regimens were purely from a physical point of view. But in recent years, attempts have been made to relate the physics of microenvironments to processes in plants and animals, in an effort to explain disjunctive distribution, vegetational history, and dynamic vegetational phenomena such as succession. That these attempts have only been partly successful is not condemnation of such research. Indeed, recognition of the objective is some progress in itself.

Three great needs in current researches are recognized. These include: (1) accumulation of weather data vertically and horizontally in plant communities, (2) concomitant observations of plant and animal behavior in the field where measurements are made, (3) discovery of the relationships of macroclimate or general weather to the microclimatic regimens in local situations, and (4) the working out of energy budgets for various vegetation types such as grasslands, forest and desert communities. The authors are not unaware of genetic problems involved. Indeed, they are of coequal significance, but beyond the intent of this report.

It is the purpose of the present investigators to contribute data to these areas in a series of papers to which this is introductory, describe a problem area, and state the over-all long time objectives of these studies.

Wolfe, Wareham, and Scofield (1949) published a rather detailed account of the multiplicity of microenvironments in a small valley called *Neotoma* in Hocking County, Ohio. During the period 1939–44, they visited the area weekly, reading and resetting between 100 and 300 instruments and recording the data. "In addition, a number of special trips of one to several days' duration were made at different seasons, during which time several factors were measured at 15-, 30- or 60-minute intervals for periods of 5 to 24 hours. Data were recorded concerning the following phenomena; minimum and maximum air temperatures near the substrate; minimum and maximum air temperatures beneath the leaf litter; minimum and maximum air temperatures 5 ft. above the substrate; soil temperatures at a depth of 9 to 12 in.; plant temperatures; relative light intensities; precipitation; evaporation from atmometers; soil moisture fluctuations; vapor pressure; flowering periods of plants; seasonal variations in the rates of plant growth; and seasonal conditions of plants."

While these laborious and time consuming studies succeeded in citing or suggesting a considerable number of weather regimens and conditions near the substrate previously overlooked or poorly evaluated, their investigations left numerous problems and measurements untouched.

Consequently a new set-up was planned to further refine these measurements

[1]Publication 579, Department of Botany and Plant Pathology, The Ohio State University.

and accomplish new ones both above and below the forest floor, and to set forth certain tentative principles of microclimatology. By February of 1953, a half-mile power line was installed, extending up-valley along the banks of Arbutus Run, a small stream now cutting into the valley. From the terminus of this line, lines were extended to selected stations in the valley bottom, and the two opposing slopes, where certain temperature, precipitation, light and wind phenomena are recorded continually by electrically-powered instruments.

Vegetation of Neotoma Slopes

This valley, except for certain local pine plantings has been undisturbed since 1922, a period of 33 years. Prior to that time it had been severely lumbered, and in places, clear cut. Vegetational development since the early 1920's is indicated in figures 1 to 3.

The vegetation on the north-facing slope may be considered a young mixed mesophytic community. Canopy species[2] include:

Beech *Fagus grandifolia*[3]
Sweet Birch *Betula lenta*
Hemlock *Tsuga canadensis*
Butternut *Juglans cinerea*
Black Walnut *J. nigra*
Black Cherry *Prunus serotina*
Great-toothed Aspen *Populus grandidentata*
Sassafras *Sassafras albidum*
Tulip *Liriodendron tulipifera*
Red Maple *Acer rubrum*
White Oak *Quercus alba*
Red Oak *Q. rubra*
Chestnut Oak *Q. prinus*
White Ash *Fraxinus america*
Sugar Maple *Acer saccharunam*

The relative youthfulness of this forest community is at once apparent because of (1) certain areas of discontinuous canopy, (2) young age and small size of the trees, only a few being two centuries old and none attaining diameters of more that 2.5 ft., and (3) the persistance from an earlier stage in succession of such species as Aspen, Sassafras and Chestnut-oak. Moreover the small trees and shrubs are relatively dense, although species of the earlier developmental stages (Blackberry, Hazelnut, Mountain Laurel and the like) are much reduced in numbers, depauperate, or absent over large areas.

Small trees and shrubs include:

Carpinus caroliniana American Hornbeam
Viburnum acerifolium Maple-leaved Viburnum
Dirca palustris Leatherwood
Smilax glauca Glaucous Greenbrier
Fagus grandifolia Beech
Betula lenta Sweet Birch
Amelanchier canadensis Shadbush
Carya ovata Shagbark-Hickory
Sassafras albidum Sassafras
Acer rubrum Red Maple
Cornus florida Flowering Dogwood
Prunus serotina Black Cherry
Corylus americana Hazelnut
Liriodendron tulipifera Tuliptree
Parthenocissus quinquefolia Virginia Creeper
Lindera benzoin Spicebush
Viburnum prunifolium Blackhaw
Quercus rubra Red Oak
Fraxinus americana White Ash
Rhus toxicodendron Poison Ivy
Carya spp. Hickory
Hydrangea arborescens Wild Hydrangea

The groundcover is relatively luxuriant, expecially in spring, as contrasted with that of the south-facing slope. It too, however, contains a number of species persisting from a less mesic environment. A recording of the fluctuations in numbers and other changes in the herbaceous society is one of the objectives of

[3]Originally chestnut was significant.
[2]Nomenclature essentially that of Gray's 8th edition (Fernald 1950).

this long time study, for it is in this community that population changes are most rapid and frequent. Moreover this level represents the substrate of microclimatic control during the spring, late fall and winter seasons.

Species making up the herbaceous layer and ground cover on the north-facing slope are (spring aspect):

Polygonatum biflorum True Solomon's Seal
Anemonella thalictroides Rue-Anemone
Smilacina racemosa False Solomon's Plume
Goodyera pubescens Rattlesnake Plantain
Claytonia virginica Spring Beauty
Polemonium reptans Bluebell
Poa cuspidata Forest Blue-grass
Pyrola rotundifolia Shinleaf
Polystichum acrostichoides Christmas-Fern
Aplectrum hyemale Putty-root
Trillium grandiflorum Showy Trillium
Hepatica acutiloba Liverleaf
Luzula spp. Woodrushes
Phlox divaricata Sweet William
Dentaria laciniata Crowfoot
Galium spp. Bedstraw
Obolaria virginica Moneywort

Changes and seasonal aspects over a period of years in this community will be reported later.

The vegetation of the south-facing slope at *Neotoma* was originally dominated by Oak and Chestnut. With the death of Chestnut and subsequent lumbering, there developed on this site secondary forest of mixed oak, undisturbed at this writing for a third of a century. The canopy species include:

Chestnut oak *Quercus prinus*
Black oak *Q. velutina*
Post Oak *Q. stellata*
White oak *Q. alba*
Hickory *Carya* spp.
Scarlet oak *Q. coccinea*
Sourwood *Oxydendrum arboreum*
Pitch Pine *Pinus rigida*
Red Maple *Acer rubrum*

Rare associates include poorly developed beech, hemlock, tulip—all in special edaphic or microclimatic sites and not ordinarily considered part of the vegetation of the slope.

Small trees and shrubs include:

Kalmia latifolia Mountain-Laurel
Vaccinium vacillans Blueberry
Fagus americana Beech
Acer rubrum Red Maple
Carya spp. Hickory
Oxydendrum arboreum Sourwood
Gaylussacia baccata Huckleberry
Pinus rigida Pitch Pine
Pinus echinata Short-leaf Pine
Epigaea repens Trailing Arbutus
Sassafras albidum Sassafras
Betula lenta Sweet Birch
Smilax glauca Glaucous Greenbrier
Parthenocissus quinquefolia Virginia Creeper
Cornus florida Flowering Dogwood
Viburnum acerifolium Maple-leaved Viburnum
Nyssa sylvatica Black Gum
Quercus prinus Chestnut Oak
Q. velutina Black Oak
Q. coccinea Scarlet Oak
Gaultheria procumbens Teaberry
Chimaphila maculata Wintergreen
Rosa virginiana Virginia Rose

The forest floor of this slope is about 50 percent devoid of a leaf litter cover. The mosses *Leucobryum glaucum*, *Polytrichum ohioense*, *P. juniperinum*, and *Dicranum scoparium* form prominent colonies in the bare areas as do the primary thalli of *Cladonia* spp. Herbs in the spring aspect (season same as that for list of species on N-facing slope) include:

Hieracium venosum (rosette) Veined Hawkweed
Gerardia flava (rosette) Smooth False Foxglove
Viola triloba Lobe-Leafed Violet
Danthonia spicata Poverty Grass
Panicum lanuginosum Panic Grass

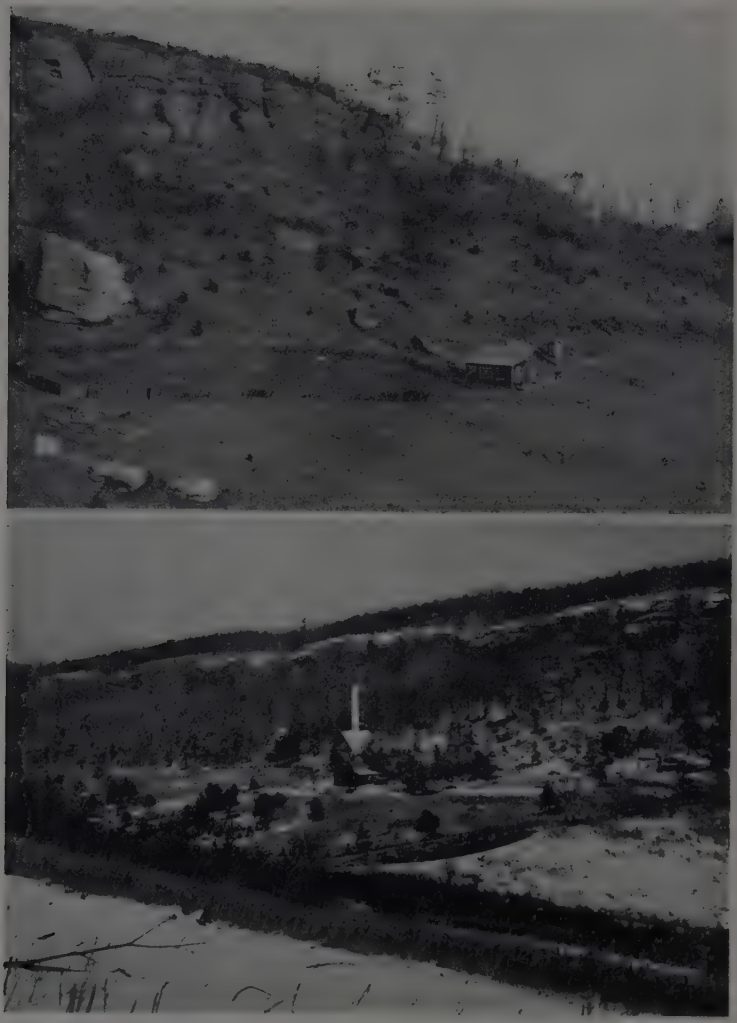

FIGURE 1. (Top) View of southwest facing slope at *Neotoma* in 1924. Edward S. Thomas.

FIGURE 2. (Bottom) View of southwest facing slope at *Neotoma* in 1941. R. T. Wareham. Cabin to which arrow points is the same as that in figure 1.

Quadrat Tabulations. Biological studies of various kinds have been conducted at Neotoma for more than 30 years (Wolfe *et al.* 1949, pp. 37, 39) but no quantitative data concerning the vegetation have ever been published. Indeed, for purposes of describing successional dynamics, simple inspection will suffice, as might be inferred from figures 1 to 3.

The current tabulations are not intended to be exhaustively descriptive of the communities, although they are rather representative of the forest complexes on the opposing slopes as of 1955. Primary objectives are to circumscribe areas where seasonal changes could be noted and compared with measurements of weather elements; where changes in populations could be noted from year to year or decade to decade; and comparisions made between the populations of the two slopes.

FIGURE 3. View of southwest facing slope at *Neotoma* in 1955. Cabin to which arrow points is the same as that in figure 1.

The following data (tables 1, 2) are based on six 10 x 10 meter quadrats adjacent to the weather stations on the two slopes. These tables include only a record of woody species. It is planned to report changes in aspect and populations at appropriate intervals.

Ecological Life Histories and Phenology. Records are kept and will be reported in detail, of stage of development of most of the species composing the vegetation of Neotoma Valley and vicinity. Emphasis is placed on times of germination, breaking of dormancy, flowering, fruiting, leaf fall, beginning of dormancy, and duration of dormancy. A sample record of a year's observation of tulip-tree follows:

4/15/54	Buds swelling
4/23	Leaves unfolding and expanding
4/27	Leaves unfolding and expanding; expanded to 3″ in tree tops
5/4	Leaves ¼ to ½ expanded
5/10	Some of newest leaves killed by cold snap; flower buds greatly swollen
5/11	Leaves expanded ½; flowers in late bud
5/15	Leaves ½ to ⅔ expanded
5/18	Leaves mostly ¾ expanded; flower buds breaking
5/27	Leaves almost fully expanded; in flower
6/12	Leaves not yet fully expanded; still in flower but past peak
6/21	Young fruits
7/15	Fruits 1-½ to 2″ long, green
8/5	Fruits fully formed, green
10/12	Leaves mostly yellow
10/19	Leaves nearly all yellow
10/26	Many leaves fallen
10/29	Leaves brown-tinged, less than ½ defoliated
11/9	Mostly defoliated; persistent leaves brown
11/30	Seed falling
1/ 2/55	Great seed fall
1/11	Seed still falling
1/18	Continued fall of seed
1/25	Few seeds still falling
3/24	Sprout buds greening
4/ 5	Buds swelling and breaking at tree tops
4/12	Most buds swollen or broken

These various stages and conditions of the more than 400 species observed are studied in relation to coincident measurements of various weather elements in an attempt to correlate behavior with environmental patterns.

In addition, using the dendrometer techniques of Daubenmire (1945) and Fritts (1956), records are kept of radial growth of 11 tree species on the north-facing slope, and five species on the south-facing slope.

THE MASTER WEATHER STATION

To eliminate geography as a factor in contrasting macroclimatic and microclimatic differences, a master weather station is in operation in the open in the valley between the two slope stations. Here air temperatures at five feet above the substrate in a standard shelter are recorded by means of a thermograph; precipitation is measured by both weight and volumetric gages, the latter electrically operated. Wind direction and velocity at height of 15 ft. above the valley floor are registered continuously; and a sunshine duration light meter is in operation. Barometric pressure is recorded by a microbarograph.

Also in the open are located one Weather Bureau rain gage of the weight-recording type, essential to sampling winter precipitation when the tipping bucket instrument is not in operation, and two standard 8 in. diameter non-recording gages.

Some comparative weather data of the U. S. Weather Bureau at Lancaster (9 miles distant) and Neotoma master station for single weeks in January, April, July and October are included in table 3.

THE MICROCLIMATIC STATIONS

Temperatures. On both slopes, instrument shelters have been installed, each containing a Leeds and Northrup micromax recorder. The recorder on the

north-facing slope is equipped with 16 thermocuple leads, while the recorder on the south-facing slope records temperatures from eight thermocouples[4]. On both slopes the first eight thermocouples are disposed as follows:

1. 3 ft. below surface of forest floor
2. 18 in. below surface of forest floor
3. 6 in. below surface of forest floor
4. Just beneath leaf litter
5. On surface of leaf litter
6. 5 ft. above surface of forest floor
7. 24 ft. above surface of forest floor
8. 65 ft. above surface of forest floor, in but not at top of forest canopy.

The remaining eight thermocouples of the instrument on the north-facing slope are variously used: one to measure water temperature in Arbutus Run, one at a depth of 4 ft. in the soil, several to measure tree trunk temperatures and several for short time measurements of various phenomena.

Detailed data for the various seasons are to be reported separately, but some sample data for single weeks in January, April, July and October are recorded in table 4.

Also on both slopes are standard shelters containing thermographs.

Precipitation. Sampling of rainfall and snowfall is being accomplished at all three stations. In the open, rainfall is recorded volumetrically by a Friez tipping bucket rain gage. From these records, time, duration, and a sample of amount of precipitation may be obtained, and intensity may be calculated. These data may then be compared with records obtained within the two forest types by means of can-type gages constructed in the Botanical Laboratories at Ohio State University. The catch in these gages when taken in the open is not significantly different from the samples obtained from adjacent standard U. S. Weather Bureau instruments. Six can gages are disposed on each slope along a 75 ft. line (fig. 4). Some sample winter and summer records are given in table 5.

Still another approach to sampling percipitation in vegetation is being attempted. On each slope is a galvanized iron trough type rain gage, 96 ft. long, 1½ in. wide and 3 in. deep (fig. 4). Water from these troughs flows into electrically recording tipping buckets. These data have already been useful in determining rate of melt of snow on the forest floor in the winter seasons; and data are being collected which will aid in the analysis of individual rains at the forest floor level.

Rate of Spring Flow. There are several seepage springs in Neotoma Valley, one of which is within the mesophytic forest. The rate of flow and temperature of this spring is recorded weekly and comparisons are made with two other nearby artesian springs. However, most important to the ecological point of view, are the relations of rate of flow to precipitation, percolation, snow persistence, and transpiration. Sample records showing rate of flow and precipitation regimens are given in table 6.

Soil Moisture. Determinations of soil moisture on both slopes and in the valley bottom at 1 to 3 and 6 to 9 in. depths are made weekly. The dominate soil type on both slopes is Muskingum fine sandy loam, characterized by rockiness near the surface. Terrace remnants near the base of each slope and the bottom lands are dominated by Holston silt loam and Atkins silt loam respectively (Conrey *et al.* 1948).

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[4]The location of the recorders was reversed during early September, 1955.

Distinct differences in reaction of the soils prevail, those on the mesophytic slope being medium acid (pH 5.4–6.0) and those on the oak slope being rather strongly so (pH 4.8–5.2). pH of the bottom soils is about 5.6.[5]

Soil water contents from late winter through spring and summer and into early fall are given in table 7 and illustrate the nature of these measurements.

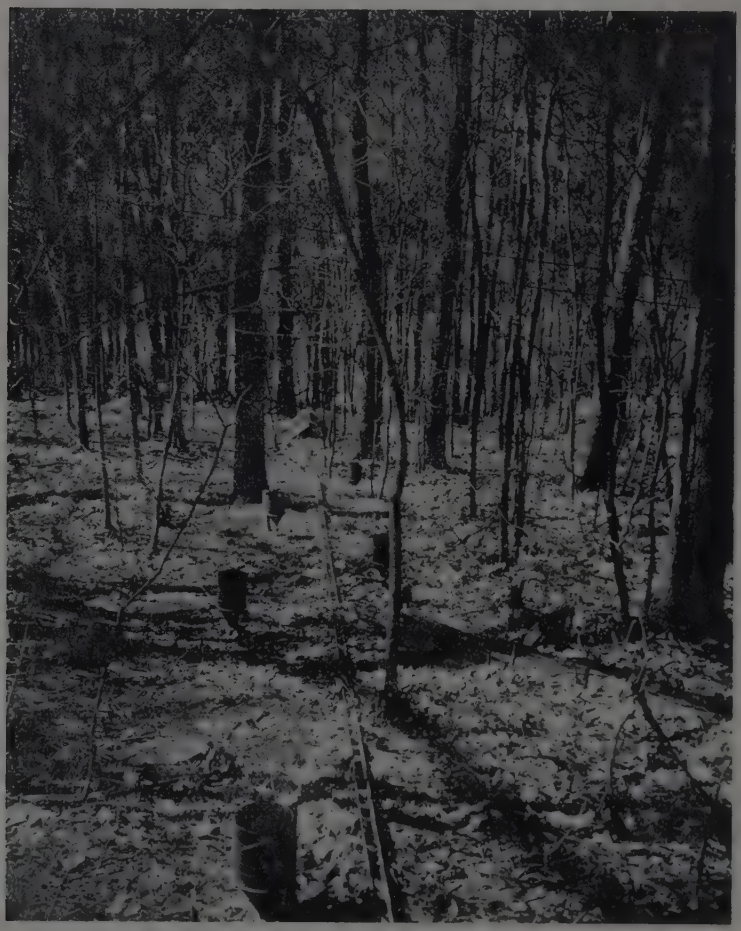

FIGURE 4. Trough and can type rain gages in young mixed oak community of southwest facing slope.

[5]The authors are indebted to Dr. Nicholas Holowaychuk, Department of Agronomy, The Ohio State University, for field assistance in the classification of the soils.

TABLE 1

Numbers and basal area of woody species greater than one inch d.b.h. in six 10 X 10 meter quadrats in a young mixed mesophytic community at Neotoma.*

	Quadrat 1		Quadrat 2		Quadrat 3		Quadrat 4		Quadrat 5		Quadrat 6		Totals	
	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}
Tulip Tree	1	170	0	—	0	—	5	265	2	107	1	50	9	592
White Ash	3	85	1	11	0	—	2	35	5	139	0	—	11	270
White Oak	2	167	0	—	4	391	0	—	0	—	1	7	7	565
Red Oak	1	31	0	—	1	58	0	—	2	97	1	73	5	259
Red Maple	1	10	3	113	1	109	2	22	0	—	0	—	7	254
Aspen	0	—	0	—	0	—	1	97	0	—	0	—	1	97
Beech	1	7	0	—	2	87	0	—	0	—	0	—	3	94
Ironwood	5	15	7	17	5	10	7	18	4	13	7	22	35	95
Butternut	0	—	0	—	0	—	1	59	0	—	0	—	1	59
Sweet Birch	0	—	0	—	0	—	1	57	0	—	0	—	1	57
Dogwood	3	12	1	11	0	—	0	—	0	—	5	22	9	45
Sassafras	0	—	1	27	0	—	0	—	0	—	0	—	1	27
Shadbush	0	—	0	—	0	—	0	—	1	4	0	—	1	4
Totals	17	497	13	179	13	655	19	553	14	360	15	174	91	2418

*Woody species less than one inch d.b.h. included: ironwood, maple-leaved viburnum, leatherwood, glaucous greenbrier, beech, sweet birch, shadbush, shagbark-hickory, sassafras, red maple, flowering dogwood, black cherry, hazelnut, tuliptree, virginia creeper, spicebush, blackhaw, red oak, white ash, posion ivy, hickories, and wild hydrangea.

TABLE 2

Numbers and basal area of woody species greater than one inch d.b.h. in six 10 × 10 meter quadrats in a young mixed oak community at Neotoma.*

	Quadrat 1		Quadrat 2		Quadrat 3		Quadrat 4		Quadrat 5		Quadrat 6		Totals	
	No.	B.A. in.²	No.	B.A. in.²	No.	B.A. in.²	No.	B.A. in.²	No.	B.A. in.²	No.	B.A. in.²	No.	B.A. in.²
White Oak	2	59	2	37	3	31	1	633	5	37	1	2	14	799
Black Oak	6	119	0	0	7	106	3	41	1	88	2	34	19	388
Chestnut Oak	0	0	0	0	2	253	1	16	2	22	2	18	7	309
Scarlet Oak	1	48	2	163	0	0	0	0	0	0	3	49	6	260
Hickory spp.	1	7	3	26	4	119	2	30	2	116	1	3	13	301
Red Oak	0	0	0	0	0	0	0	0	2	99	0	0	2	99
Red Maple	3	6	3	27	5	13	2	25	6	14	3	5	22	90
Sourwood	0	0	0	0	0	0	1	6	4	18	2	7	7	31
Dogwood	4	6	0	0	0	0	1	14	1	1	1	2	7	23
Sweet Birch	0	0	1	22	0	0	0	0	0	0	0	0	1	22
Beech	0	0	4	17	0	0	0	0	0	0	5	5	9	22
Black Gum	0	0	2	7	1	2	0	0	0	0	1	2	4	11
Sassafras	0	0	0	0	0	0	0	0	1	9	0	0	1	9
Totals	17	245	17	299	22	524	11	765	24	404	21	127	112	2364

*Woody species less than one inch d.b.h. included: mountain-laurel, blueberry, beech, red maple, hickory, sourwood, huckleberry, pine, trailing arbutus, sassafras, sweet birch, glaucous greenbrier, virginia creeper, flowering dogwood, maple-leaved viburnum, chestnut oak, scarlet oak, black oak, teaberry, wintergreen, black gum, and *Rosa virginiana*.

OBJECTIVES OF INVESTIGATIONS

1. To seek relationships between behavior of native plant species (notably dormancy, germination and breaking of dormancy, vegetative and reproductive growth) and the microenvironments in which they live.
2. To further define climates near the forest floor and analyze other climatic strata in the forest, at all seasons of the year.
3. To measure both temperatures and moisture fluctuations beneath the forest leaf litter and in the root zones of the soil below.
4. To obtain and analyze data on water relations in forest vegetation with special consideration of: amounts and types of precipitation, interception, intensity, run-off, evaporation, and percolation.
5. To obtain sufficient data concerning microclimates that Weather Bureau data may be used as a basis for inferring forest weather conditions. If this can be done, the long time nature of certain weather records may prove of considerable importance biologically.
6. To obtain ecological life histories of as many species as possible, *i.e.*, to follow the history of individuals from seed to maturity and determine the conditions under which each stage exists.

ACKNOWLEDGMENTS

The establishment and continuation of this research would have been impossible without the aid and cooperation of numerous people and institutions. We are especially indebted, however, to the following: The University Advisory Committee on Research Grants, former Dean N. Paul Hudson, Chairman, which allocated funds permitting the purchase of equipment and obtaining of clerical and technical assistance. The College of Agriculture supplied sufficient funds for the purchase of one electrical temperature recording device. Edward S. Thomas and John Freeman have graciously permitted the use of their land. The extension of electric power into the problem area was the result of the interest and cooperation of The Ohio Power Company. Our own department has contributed much in the way of equipment and expendable materials necessary in such research. We are indeed grateful to The Service Department of The Ohio State University which on numerous occasions has supplied necessary transportation for haulage of heavy materials to the research area. Basic soil tests were conducted by The Department of Agronomy.

TABLE 3

Comparative air temperature and precipitation data of U.S.W.B. at Lancaster, Ohio and open weather station at Neotoma, 1954 and 1955.

Month		Avg. Max. °F.		Avg. Min. °F.		Avg. °F.		Ppt. in Inches	
		N.	L.	N.	L.	N.	L.	N.	L.
January	54	38.3	41.6	22.6	24.6	30.5	33.1	2.78	2.49
	55	35.9	38.5	20.8	22.8	28.4	30.7	1.50	1.25
April	54	68.8	70.2	41.7	42.9	55.2	56.6	2.93	3.20
	55	66.8	71.9	40.4	45.0	53.6	58.5	3.40	3.70
July	54	84.5	89.4	55.5	61.4	70.0	75.4	4.58	3.65
	55	85.0	91.1	63.0	67.3	74.0	79.2	3.15	3.24
October	54	63.4	68.2	43.0	47.1	53.2	57.7	4.74	3.59
	55	64.1	67.6	39.7	42.8	51.9	55.2	2.93	3.01

TABLE 4

Certain Temperature Data from Habitats at Neotoma for weekly periods at Various Seasons 1953–1954.

	Apr. 19–25, 53			Jul. 19–25, 53			Sept. 6–12, 53			Dec. 21–27, 54		
	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
In soil 36"												
N–F Slope	46.0	48	44	62.6	64	61	62.5	64	61	44.3	45	42
S–F Slope	46.4	48	45	63.7	64	62	63.3	65	62	44.6	46	44
In soil 18"												
N–F Slope	46.0	48	44	63.4	64	62	62.6	65	61	42.1	44	41
S–F Slope	45.4	48	44	64.9	66	64	63.3	65	62	43.3	44	43
In soil 6"												
N–F Slope	46.6	52	44	66.9	69	62	63.1	66	60	41.6	43	40
S–F Slope	48.0	58	40	71.0	76	64	64.5	68	61	41.1	44	38
Under LL												
N–F Slope	46.9	54	42	67.9	72	60	62.0	66	57	38.3	46	36
S–F Slope	48.3	64	38	71.6	80	61	63.6	70	56	37.0	48	28
On LL Suf.												
N–F Slope	52.6	106	28	68.4	74	58	62.3	79	45	33.7	66	20
S–F Slope	53.0	111	28	73.6	96	54	64.4	86	47	33 9	67	13
Air at 5'												
N–F Slope	51.7	80	26	70.9	86	50	62.3	79	45	32.4	60	6
S–F Slope	52.1	82	24	73.1	92	50	63.6	83	45	33.1	63	6
Lancaster WB		78	23		95	51		84	44		60	3
Air at 20'												
N–F Slope	51.7	78	26	71.9	88	50	62.6	80	45	32.9	62	6
S–F Slope	52.9	80	26	74.7	94	51	64.3	83	45	33.7	62	7
Air 65'												
N–F Slope	51.7	79	26	72.2	89	50	63.3	83	45	33.9	65	6
Stream Water	48.7	58	40	70.0	76	58	62.6	69	54	36.3	39	34

TABLE 5

Weekly precipitation in inches occuring in open and opposing slopes during winter and summer seasons at Neotoma.

Winter (12/54–5/55)			Summer (5/55–9/55)		
MM.	OC.	Open	MM.	OC.	Open
0.60	0.54	0.60	1.80	1.88	2.03
1.53	1.36	1.53	0.45	0.42	0.53
1.11	1.03	1.13	0.49	0.57	0.51
0 39	0.37	0.37	0.74	0.72	0.72
1.77	1.75	1.82	0.57	0.51	0.49
2.03	1.76	1.79	0 96	0.94	1.00
1.56	1.46	1.59	0.23	0.22	0.28
1.96	1.85	1.77	1.46	1.42	1.53
0.63	0 66	0.77	0.03	0.03	0.06
1.60	1.62	1.65	0.11	0.11	0.16
0.32	0.29	0.23	1.29	1.28	1.31
1.06	1.01	0.97	0.20	0.20	0.25
1.10	1.12	1.10	0.59	0.53	0.70
1 29	1.27	1.28	0	0	0.10
0 06	0.04	0.10	0	0	0.02
17.01	16.13	16.70	8.92	8.83	10.55

TABLE 6

Neotoma spring flow data, 1955.

Date	gal./min.	Remarks
1/4	0.53	
1/11	0.47	
1/18	0.48	frequent light snows in January
1/25	0.41	
2/1	0.46	
2/8	0.76	1.50″ rain on 2/6
2/15	0.49	
2/19	0.70	0.60″ rain on 2/16
2/22	3.16	10 hours following 0.50″ rain
2/27	3.33	8 hours following 0.80″ rain
3/8	1.05	1.70″ rain on 3/5
3/15	0.85	immediately following 0.30″ rain
3/22	5.45	1.40″ rain on 3/21
3/29	0.78	
4/5	0.67	following 10 rainless days
4/12	0.86	0.40″ rain on 4/11
4/19	1.28	immediately following 0.40″ rain
4/26	2.22	1.30″ rain between 4/21 and 4/25
5/3	0.91	
5/10	0.67	
5/24	0.60	
6/14	0.48	
7/5	0.39	
7/12	0.39	
7/26	0.33	
8/2	0.34	
8/9	0.31	
8/16	0.29	
8/23	0.37	frequent but light showers during May, June, July,
8/25	0.37	August, September & October
8/30	0.34	
9/5	0.29	
9/13	0.25	
9/20	0.25	
10/4	0.35	
10/11	0.39	
10/17	0.43	
10/21	0.36	
10/25	0.42	
11/1	0.39	
11/8	0.38	
11/15	2.67	immediately following 1.16″ rain
11/22	0.56	
11/29	0.39	
12/6	0.46	
12/13	0.41	
12/20	0.38	
12/27	0.35	

TABLE 7

Comparative available soil moisture data in percent (dry weight basis) for opposing slopes and valley soils at Neotoma, 1955.

	Mixed Mesophytic		Oak Chestnut		Open (valley)	
	1–3 in.	6–9 in.	1–3 in.	6–9 in.	1–3 in.	6–9 in.
Wilting %*	5.5	3.6	4.5	3.0	8.4	13.3
4/19	37	20	37	20	31	26
4/26	35	19	31	17	29	22
5/3	26	16	24	15	33	25
5/10	22	13	28	17	28	25
5/17	27	15	27	16	30	26
5/24	25	14	29	15	25	23
6/1	22	13	23	14	24	28
6/7	26	13	27	14	31	25
6/14	26	15	25	13	33	20
6/21	19	13	14	12	34	18
6/28	22	12	12	11	32	19
7/5	19	11	10	7	22	26
7/12	21	12	14	9	23	26
7/19	11	9	8	5	22	20
7/26	10	10	4	4	16	17
8/2	10	11	5	5	16	17
8/9	8	6	0	3	16	15
8/16	10	5	3	1	14	12
8/23	18	13	11	11	20	20
8/30	11	8	8	6	19	15
9/5	6	8	2	3	13	18
9/13	5	3	1	2	6	12
9/20	3	2	2	2	8	7
9/27	10	4	7	2	17	12
10/4	11	9	8	8	21	18
10/11	16	11	15	10	21	18
10/17	19	17	14	11	22	23
10/25	23	18	14	11	20	17
11/1	19	13	10	8	23	20
11/8	24	14	13	11	23	19
11/15	28	18	22	14	24	21
11/22	24	16	22	16	28	21
11/29	23	15	17	16	23	29
12/6	22	16	21	16	25	28

*Pressure membrane at 15 atmospheres.

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NOTES ON SOME UNUSUAL FLORA FOUND IN ATHENS COUNTY, OHIO

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. . . . Athens County, Ohio, has a rich and varied flora. Here we find plants which are more common farther north, such as *Symplocarpus foetidus* (L.) Nutt., and *Ilex verticillata* (L.) Gray: Appalachian plants, such as *Lygodium palmatum* (Bernh.) SW; and southern plants, in the case of *Corallorhiza Wisteriana* Conrad, *Phlox stolonifera* Sims, and *Chionanthus virginicus* L.; Prairie species include *Filipendula rubra* (Hill) Robins, (Queen of the Prairie) and *Echinacea purpurea* (L.) Moench. (Purple Cone Flower). Much of the collecting has been done with the help of Mr. P. S. Wamsley of Athens High School, who also collaborated in the identification.

This paper does not include either the orchids of Athens County, which were reported in the Ohio Journal of Science for May, 1953, or the grasses or sedges which have not been worked over. This record of the plants of Athens County may be valuable as historical data. Some of the stations have been lost due to the building of homes, roads, industries, and businesses. Any land in this area which will yield a thin strip of low-grade coal is rapidly being turned into a desert fit only for planting locust and sweet clover, and much of the original flora will disappear.

Most of the collecting has been done in the northern townships of Trimble, York, Dover, Ames, Bern, Waterloo, Athens, Canaan, and Rome. The southern townships of Lee, Alexander, Lodi, Carthage, and Troy have not been worked over as thoroughly as the others.

Waterloo Township falls into three areas: 1. The Enderlin Forest or York Forest on former Carbondale Coal Co. land, a pine forest planted between 1906 and 1926, at the rate of 12,000 annually by Col. Richard Enderlin and Melvin Doolittle; 2. The Waterloo State Forest planted in 1915; 3. The Izaak Walton League farm, a large part of which has been preserved in its natural state.

The prairie patch –"Buffalo Beat"—in south-western Trimble Township is like a small prairie with many species found abundantly farther west. Remnants of the Hocking Canal at Armitage, Ohio, in Athens Township, is still worthy of study for the aquatic vegetation. The plains and the Beaumont areas in Section 24, Athens Township, and Section 19, Dover Township, have some boggy places which are not common in this area.

The Enderlin Forest at Carbondale, Ohio, which is in Section 36, Waterloo Township, has some interesting remnants. Scattered patches of Sphagnum moss may be found occasionally. In this area is found many species of ferns including *Ophioglossum vulgatum* L. (Adders Tongue Fern) and *Lygodium palmatum* (Bernh.) SW (Climbing Fern). *L. Palmatum* is very rare in Ohio. This station was the first reported for the state to The Ohio State University Herbarium by Prof. A. W. Boetticher of Ohio University. *Echinacea purpurea* (L.) Moench. (Purple Cone Flower) was found on the western edge of this section. *Lobelia elongata* Small and *Scrophularia lanceolata* Pursh are found here. *Meehania cordata* (Nutt.) Pursh is found near Carbondale, Ohio.

The Waterloo State Forest area, which is in the corners of Sections 25–26–31–32, Waterloo Township, consists of pine planting and some hardwood forest in its original condition. *Phlox stolonifera* Sims. grows in the hardwood forest. A few specimens of *Solidago squarrosa* Muhl., rare in Athens County, were found near the Ranger's Station. It shows no sign of spreading. Near the Ranger's Station,

white pine is showing signs of seeding among hardwoods near by. Several young trees, four and five feet high, were observed on the H. C. Bobo property southeast of the forest. There is not much evidence of white pine developing beyond the seedling stages here. White pine has done well in this area.

The Izaak Walton League farm in sections 25-31 of Waterloo Township has been preserved in its natural state with planting only on the barren fringes of the area. A lake has been made in the principal hollow inundating some interesting flora. There is a station for *Lygodium palmatum* L. on the farm. *Asplenium pinnatifidum* Nutt. (Pinnatifid Spleenwort) was found on the sandstone here. It disappeared from this location in 1953-54 when no specimens were found. In 1955, it appeared on the same place stronger than before. Small patches of Sphagnum moss are found in wet places. *Epigaea repens* L. (Trailing Arbutus) and *Kalmia latifolia* L. (Mountain Laurel) are still holding their own here. One large hillside is covered with *Lycopodium complanatum* L. (Trailing Club Moss). *L. complanatum* lingers on eroded hillsides where there is moisture. On a cut bank along U. S. Rt. 50 south of Athens, it is spreading over the new cut.

The "Prairie Patch" or "Buffalo Beat" at Buchtel, and the neighboring country, was shown to us by Mr. Leonard Stephenson, who first reported it to The Ohio State University Herbarium. Mr. Stephenson also identified the plants. Several prairie grasses, such as *Andropogon Gerardi* Vitman (Big Blue Stem), *A. scoparium* Michx. (Little Blue Stem), and *Sorgastrum nutans* (L.) Nash (Indian Grass), still grow here. Three species of *Liatris*[1] (Blazing Star), *L. cylindracea* Michx., *L. scariosa* (L.) Willd., and *L. spicata* (L.) Willd., are becoming scarce due to picking and digging. *Eryngium yuccifolium* Michx. (Rattlesnakemaster) and *Gentiana flavida* Gray (Yellow Gentian) are disappearing. A species of Baptisia grows here, possibly *B. Australis* (L.) R. Br. (Blue False Indigo) which may not be reported. Our specimen is not in flower.

This little patch of prairie has resisted the encroachment of the forest for a long time. It is possible that these plants may be crowded out by sweet clover, *Melilotus* (L.) Lam. *Melilotus* was reported for this station in 1929 by Prof. A. W. Boetticher. It is my opinion that it has made great headway during the last six years. This plant seems to do well under drought conditions.

The remnants of the Hocking Canal at Armitage, Ohio, which consists of three ponds between the C&O and NYC R. R. tracks, still yield interesting aquatic flora including *Potamogeton filliformis* Pers. (Pondweed) (not formerly reported by us), *P. nodosus* Poir. (Knotty Pondweed), *Utricularia gibba* L. (Humped Bladderwort), and *Heteranthera dubia* (Jacq.) Mac M. (Water Star Grass). *Cacalia suaveolens* L. (Sweet Scented Indian Plantain) was found in swampy ground between the first and second ponds. Nearby mine reservoirs yield others including *P. diversifolius* Raf.

The plains, Ohio, area in northern Athens Township and southern Dover township shows a boggy condition around the edge of the plain. On this springy ground may be found *Symplocarpus foetidus* (L.) Nutt. (Skunk Cabbage), *Filipendula rubra* (Hill) Rob. (Queen of the Prairie), *Ilex verticillata* (L.) Gr. (Winterberry) and *Nasturtium officinale* R. Br. (True Water-cress) which is not common in Athens County: *Potamegeton diversifolius* Raf. (Rafinesque's Pondweed) grows in a nearby Hocking mine reservoir. On a dry hillside on Vore Ridge, *Grindelia lanceolata* Nutt. (Lance-leaved Gumweed) is spread over a considerable area. Near the site of the Athens City dump, *Galium verum* L. (Yellow Bedstraw) was found by Mr. C. L. Colmer.

On the sandstone cliffs or caves in the woods where enough moisture is present, the Walking Fern, *Camptosorus rhizophyllus* (L.) Link. still holds its own near Athens, Ohio. The same areas are rich in moss flora, also some liverworts. There

[1]Species of Liatris as found in Gray's Manual of Botany, 8th edition.

are two stations for *Pellea atropurpurea* (L.) Link. (Purple Cliff-Brake) on sandstone known for Athens County.

The railroad tracks, particularly the B&O, have given us *Viola Kitaibeliana* var. *Rafinesquii* (Greene). This is also found in Alexander Township. In the railroad yards at Athens, *Onoethera lacinata* Hill is fairly well established, but not abundant.

Sagina procumbens (Procumbent Speedwell—Birdseye) is found generally at Athens, Ohio, growing between the bricks on the side streets and walks at Ohio University. This plant blooms and produces seed every month of the year with the exception of a few seasons of prolonged cold weather.

Dirca palustris L. (Leatherwood) seems to be disappearing. Twenty years ago it was plentiful in the hills near Athens, Ohio. One station at the Girl Scouts Camp in Athens Township is still intact. Another was recently reported along Shade Creek in Lodi Township and another along U. S. Rt. 33 about three miles north of Athens, Ohio.

In the herbarium at Athens High School, we have many specimens of composites, grasses, and sedges which may be examined by anyone interested.

Experimental Design and Its Statistical Basis. *D. J. Finney.* The University of Chicago Press, Chicago 37, Illinois. 1955. pp. 169. $4.50.

A biological experiment involves (1) an idea, (2) one or more variables, (3) an experimental design, (4) a statistical analysis, and (5) an interpretation. This book by Finney is an introductory account of the role of design in planning experiments. Biologists will profit from reading it. The exposition is remarkably clear, as non-mathematical as possible, and as extensive as a short book will allow.

EARL L. GREEN

Petrography, An Introduction to the Study of Rocks in Thin Sections. *Howel Williams, Francis J. Turner* and *Charles M. Gilbert.* W. H. Freeman and Co., San Francisco, 1955. x + 406 pp. $6.50.

This work is a textbook for students of petrography at the intermediate level. It represents the combined efforts of three specialists on igneous, metamorphic and sedimentary rocks, and is a most welcome addition because of this trinity. The rock descriptions are augmented by more than three hundred "microdrawings" by Williams, and these display the graphic ability for which he is noted.

In the preface the authors state that "no new rock names have been coined." Most petrographers will be thankful for this. However, the authors have perpetuated a vast technical vocabulary, some of which would be better if permanently forgotten. Some of the phraseology is so loose as to be misleading, for example: "*Bentonite* is montmorillonite formed by alteration of vitric ash." Most petrographers regard bentonite (derived from the Fort Benton shale) as a rock name, whereas montmorillonite is surely the name of a mineral and, as such, is independent of any particular mode of origin.

Dahllite is misspelled (p. 376). Were this name not derived from the proper name Dahll, the author's spelling might be acceptable because of continued usage inasmuch as the erroneous spelling is almost as frequent as the correct.

Although most of the book is descriptive, rather than interpretive, the reviewer particularly enjoyed some of the interpretive comments, such as (p. 163): We do not subscribe to this view." (Nor does the reviewer.)

Why such highly altered rocks as serpentinites should be considered under igneous rather than metamorphic rocks is puzzling to the reviewer, except that there appears to be ample tradition for classifying some strange things under igneous rocks—strange in the sense that the minerals presently comprising them hardly could have resulted from solidification of a magma or even from pronounced deuteric effects in many cases.

While the reviewer has commented critically on some minor matters, the book is a most excellent treatment of the mineral compositions and textural characteristics of all kinds of rocks.

DUNCAN MCCONNELL

A NEW PROGRAM FOR THE FRANZ THEODORE STONE LABORATORY

The Franz Theodore Stone Laboratory at Put-in-Bay, Ohio has been the site of Ohio's principal biological station since 1925. Many teachers and scientists in Ohio schools, colleges, and universitites and in bordering states have benefited from the field courses, research and experiences enjoyed at this pleasant island location. The summer teaching program scheduled to open there on June 18, 1956 marks the beginning of the seventh decade of continuous operation by The Ohio State University of a summer biological station in the Lake Erie area. This year also marks the return to the practice of offering courses at the Laboratory through established departments on the campus.

The program for 1956 has been planned by the departments of Botany and Zoology for advanced undergraduate and graduate students who wish to round out their training with appropriate field courses. It has also been planned to meet the needs of general science and biology teachers interested in gaining a more complete knowledge of field biology and in collecting material for class room use. Courses in algae, field zoology, invertebrate zoology, limnology, and ornithology will be given during the summer of 1956.

An inter-institutional committee has been appointed to aid in the development of a long-range program designed to fill the needs of Ohio colleges and universities for instruction and research opportunities in the field aspects of biology which are often lacking or difficult to provide through on-campus programs. The committee will welcome suggestions from interested persons for developing and implementing the program.

The Institute of Hydrobiology, which existed at the Laboratory as a separate department from 1938 to October 1, 1955, has been discontinued. Its personnel and courses have been incorporated into the appropriate campus departments. Use of the facilities of the Laboratory has been made the responsibility of a Natural Resources Institute created by the University Board of Trustees in the same action which dissolved the Institute of Hydrobiology. In their action the Trustees emphasized that every effort be made to secure the fullest use of the Laboratory facilities for instruction and research. It is hoped that through the inter-institutional committee full use of the facilities for research and teaching will be developed.

Anyone interested in using the facilities for research or in sending students to the Laboratory for courses or research work is invited to address his inquiry to the Director of the Natural Resources Institute at The Ohio State University, Columbus 10, Ohio, who is serving as chairman of the inter-institutional committee for the Laboratory. A brochure describing course offerings and research opportunities will be sent on request.

CHARLES A. DAMBACH,
Director, Natural Resources Institute
The Ohio State University

Bibliography of Physical Limnology 1781-1954. *James L. Verber.* Ohio Department of Natural Resources, Division of Shore Erosion, Division of Geological Survey, Report of Investigations No. 25. (Contribution No. 4 Lake Erie Geological Research Program.)

This booklet should be welcomed by investigators interested in the physical aspects of bodies of inland water. The bibliography lists most of the important references dealing with physical limnology up to December 1954. It also includes some references that are difficult to classify as physical, chemical, or biological. The arrangement and cross indexing makes this bibliography easy to use. It is available (free) from the Division of Geological Survey, Orton Hall, Ohio State University, Columbus 10, Ohio. N. WILSON BRITT.

Genetics and Metabolism. *R. P. Wagner* and *H. K. Mitchell.* John Wiley & Sons, Inc., New York. Chapman & Hall, Ltd., London. 1955. xii+444 pp. $7.50.

Asserting the thesis that ". . . inheritance is characterizable in terms of transmission of control of relative rates of biochemical reactions . . .", the authors have achieved an integration of subjects which, for the first time, offers instructors and students a text in biochemical genetics. Drs. Wagner and Mitchell are specialists in Genetics and Biochemistry and have given import to their work by correlating these fields with those of cytology, embryology, and physiology. The book deals little with how genes are inherited and treats almost entirely what really is the subject—the nature of gene action and the effects of such action on inherited chemical differences, nutrition and metabolism, development, and disease. The work is presented objectively, and controversial topics are openly examined rather than briefly mentioned or completely ignored. While the authors concede this book offers no conclusive proof of the above thesis, they have succeeded in bringing together and presenting data, hitherto unaccessible in such form, which impart considerable support to it. Fifty-four tables and 119 figures add to this support. Paramounting this notable work is an extensive bibliography containing 726 references. The book is written for the advanced student of either genetics or biochemistry and some knowledge of the other subject is required, but it is also of value to students of medicine and to biologists in general.

HENRY L. PLAINE

Industrial Manufacturing Chemistry. *G. Martin.*
Part I, Organic. *E. I. Cooke,* Editor. Seventh Edition, 1955. xvi+752 pages.
Part II, Volume I, Inorganic. *W. Francis,* Editor. Sixth Edition, 1955. xxiii+600 pages.
Part II, Volume II, Inorganic. *W. Francis,* Editor. Sixth Edition, 1955. xxi+491 pages.
Philosophical Library, Inc., New York. $50.00, the set.

The appearance of a sixth edition of Volumes I and II on Inorganic Chemistry and a seventh edition of the Volume on Organic Chemistry of this standard reference on Industrial Chemistry, is mute evidence of the general acceptance and the high regard that industrial chemists and technologists have for this work. The three volumes have been revised and brought up-to-date, with many of the sections being completely rewritten. Various chemical processes and techniques covering both British and American practice, are described in reasonable detail. Numerous references to new books and to the technical and scientific journals make it possible for the specialized reader to obtain more detailed information on any particular subject than is possible to give in a work of this size.

The use of numerous schematic drawings and photographs of equipment add greatly to the clarity of the exposition. These volumes can be highly recommended as a source of reliable up-to-date information on the major chemical industries.

WEBSTER B. KAY.

Indian Corn in Old America. *Paul Weatherwax.* The Macmillan Co., New York. 1954. ix+253 pp. $7.50.

This is an inexpensive summary of the background of American maize culture. Professor Weatherwax, who might be called the doyen of maize botanists, has spent a number of months in Central and in South America and Mexico in the last several years. His interpretations of some of the maize problems perhaps add nothing new to theory but will serve to calm down some of the more exotic speculations and to develop a greater appreciation for the antiquity of maize culture.

American archeology and ethno-botany have suffered from somewhat dogmatic conclusions that all the American aborigines are more recent than the Old World cultures and that since they lacked draft animals and wheels they were not only mechanically primitive, but perhaps mentally as well. The architecture, mathematics and crafts in basketry and ceramics attest differently. And to these findings which present artifacts that can be measured and compared with the materials of other countries should be added the achievements in plant domestication. For study purposes we have the end results. We also have the great heritage they afford to our daily demand for supplies in this modern world. But we do not have what the botanists requires, the evidence in specimens by which the story of the modification of man of wild plant to cultigen can be told. All is conjecture.

Professor Weatherwax treats all the inferences with a delightful skepticism apparently not wishing to enter into further debate. In some instances this is a disappointment as some of his views are as worthy of presentation as those of opposite opinion.

The Macmillan Publishing Company has cooperated in generously reproducing drawings from early herbals and from museums and other learned sources to illustrate a work that aims to be worthy of its great subject. Both they and Professor Weatherwax are to be congratulated.

ADOLPH WALLER.

Recent Studies in Avian Biology. *Albert Wolfson*, Editor. University of Illinois Press, Urbana, Illinois. 1955. xiii + 479 pp. $7.50.

In the spring of 1948 a Committee on Research, of the American Ornithologists Union, embarked on the preparation of a book, the objective of which was to review and evaluate the more important areas of study and research in the field of ornithology.

The book, a joint effort of several capable and active research workers under the editorship of Albert Wolfson, has achieved a degree of excellence which should make it an invaluable source for all serious students of ornithology. The subject matter areas discussed include; systematics, evolution and paleontology, anatomy, behavior, bird navigation and migration, breeding biology, role of hormones, population studies, and diseases. Each author has presented, in superb fashion the various concepts, supporting data, and contributors in his particular field along with a critical summary. The sequence of topics and general format combine to give the book unusual uniformity and readability and the cited references form an extensive bibliography of great value to researchers.

L. S. PUTNAM

The World of Bees. *Gilbert Nixon.* Philosophical Library, Inc., New York. First edition, 1955. xxiii + 214 pp. $4.75.

This is a comprehensive popular treatise on "The World of the Bees"—solitary bees, bumble bees and honey bees. References in the text are confined entirely to British and European bee species. Well covered are the intriguing aspects of bee life and behavior such as: egg to adult; nest building; rearing of young; social life; pollen collecting; language and dances of bees; and their sense of color, smell, taste and orientation. Appropriately the author discusses the enemies and diseases that effect the welfare of bees. The mutual relationship between bees and flowers as well as the indispensable role of bees in the pollination of fruit, certain vegetable and seed crops is well portrayed. Gilbert Nixon is a well recognized British Entomologist and a specialist in the order of Hymenoptera to which bees belong.

This is a most pleasing popular book containing a wealth of information. It will be valuable to anyone wishing to attain a general background of things common to all bee life, but is not organized as a text for teaching entomological students on the college level.

WINSTON E. DUNHAM

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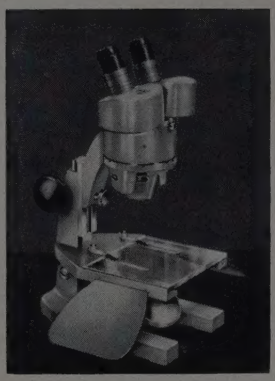

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